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Proceedings of the Acid Rain Evaluation Seminar

Edited by

R.V. Huntley and R.Z. Rivers

Comptes rendus du séminaire d'évaluation : les pluies acides

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Table of Contents/Table des matières

Abstract / Résumé iv
Preface / Préface v
Opening Remarks. R.Z. Rivers 1

PART I — OVERVIEW / PARTIE I — APERÇU GÉNÉRAL

The Bio-Physical Environment. J. Cooley 4
The Socio-Political Environment. P. Vachon 14
A Progress Review of Acid Rain Evaluation Research. T. F. Wise 18

PART II — PUBLIC PERSPECTIVE / PARTIE II — POINT DE VUE DU PUBLIC

Invitation for Participation by Interest Groups. G. C. Vernon 22
Resource Evaluation — The Public Perspective 24
J. Craik 27
J. P. Cuerrier 28
D. Hallman 28
G. Sheehy 29
W. LaBillois 30
D. Lawrance 32
J. Lawson 33
R. Liddle 34
M. Marc 35
A. Penn 36
A. Roy 39
P. Vincent 41

PART III — APPROACHES TO MEASURING THE VALUE OF THE RECREATIONAL FISHERY / PARTIE III — APPROCHES À L'ÉVALUATION DE LA PÊCHE RÉCRÉATIVE

Estimating the Economic Consequences of Acid Rain on Sportfishing — An Overview. A. Berczi 46
Acid Rain and the Measurement of Fisheries Losses: A Summary of Some Issues. J. Knetsch 52
Notes on the Hedonic Technique: A Description and Assessment. D. Gillen 55
Valuation of Benefits Generated by the Sport Fishery: Some Comments. J. Moore 58
Analysis of Willingness to Pay for Recreational Boating on Lake Ontario. A. Stillo 59
Estimating the Values of Potential Acid Precipitation Damages to Sport Fisheries in Canada — The Talhelm Approach: Advantages and Disadvantages. D. Talhelm 61
An Economic Assessment of Acid Rain Impacts on Sport Fishing in the Haliburton/Muskoka Region: Problems of Implementation and Interpretation. P. Victor 64
Basic Principles in Planning Surveys. S. O'Hara 69
La pêche récréative, étude auprès de la population : réflexions et commentaires. J. Pelletier 71
Some Plausible Fundamental Misspecifications in Models of Preferences for Acid Deposition Control. T. Crocker and B. Forster 75
The Use of Indirect Techniques in the Analysis of Supply and Demand for Recreational Fishing. C. Southey 80
Évaluation des dommages socio-économiques potentiels causés par les précipitations acides sur la pêche sportive au Québec. J. F. Gautrin 85
The Economic Impact of Acid Rain on the Commercial Atlantic Salmon Fishery. T. Pinfold 88
Data Availability and Requirements for Acid Rain Impact Evaluation. J. E. Hanna 95
Regional Planning Group Workshop Reports / Rapports d'atelier du groupe de planification régionale
Ontario / Ontario 100
Quebec / Québec 100
Other Atlantic Provinces / Autres provinces de l'Atlantique 100

APPENDICES

Position of the Canadian Tourism Industry and The Canadian Coalition on Acid Rain on Acid Rain Control 102
A Statement on Acid Rain from a Consultation of Canadian and U.S. Religious Bodies 109
List of Participants / Liste des participants 112

Abstract

HUNTLEY, R.V., AND R. Z. RIVERS [ED.]. 1986. Proceedings of the Acid Rain Evaluation Seminar. Can. Spec. Publ. Fish. Aquat. Sci. 90: 116 p.

This publication contains the proceedings of the Acid Rain Evaluation Seminar held in Ottawa, Ontario, March 13–15, 1984. The Department of Fisheries and Oceans has been actively studying the socio-economic consequences of acid precipitation since 1980. This seminar was intended to solicit opinion and advice from the various sectors of Canadian society most affected and involved in acid rain research and analysis. This counsel would form the basis for socio-economic research planning by the Department on the topic of acid rain for the next few years. Further, this direction would facilitate an appropriate allocation of resources and effort in terms of competing programs and the acid issues themselves.

Résumé

HUNTLEY, R.V. ET R.Z. RIVERS [ÉD.]. 1986. Comptes rendus du séminaire d'évaluation : les pluies acides. Publ. spéc. can. sci. halieut. aquat. 90 : 116 p.

La présente publication contient les comptes rendus du séminaire d'évaluation : les pluies acides, tenu à Ottawa (Ontario) du 13 au 15 mars 1984. Le ministère des Pêches et des Océans étudie activement, depuis 1980, les conséquences socio-économiques des précipitations acides. Le séminaire d'évaluation des pluies acides avait pour objectif de demander l'avis et les conseils de divers secteurs de la société canadienne les plus concernés par le phénomène et engagés dans la recherche et l'analyse des pluies acides. Les conseils offerts devaient former la base d'une planification de la recherche socio-économique par le Ministère dans le domaine des pluies acides au cours des prochaines années. De plus, cette orientation devait faciliter une affectation appropriée des ressources et de l'effort en ce qui concerne les programmes concurrentiels et les questions sur les pluies acides elles-mêmes.

Preface

The March 1984 Acid Rain Evaluation Seminar was sponsored by the Department of Fisheries and Oceans of the Government of Canada under the auspices of the federal Long Range Transport of Air Pollutants program. The Department has been active in acid rain socio-economic work since 1980 and has completed a number of studies on this subject. The greater part of the acid rain impacts on fisheries occur in the recreational and native fisheries, where market prices for the resources at risk to acid rain are either insufficient or nonexistent. Furthermore, the developing methodologies for evaluating the economic damages in these sectors is unproven and embroiled in substantial controversy. This degree of uncertainty over current damages estimates requires both public consultation on acid rain valuation issues and the building of a consensus as to the appropriate methodologies to be used.

The purpose of this seminar was to consult with federal and provincial economists, invited specialists and interested parties in acid rain issues, and to develop a plan of action for socio-economic research and analysis by the Department of Fisheries and Oceans for 1984/85 and beyond. The three day seminar commenced with a discussion of the historical, biological, economic, social and political aspects of the acid rain issue. This was followed by a period in which key interest groups with specific concerns on acid rain issues presented their perspectives and misgivings about current approaches to resolving the North American acid rain issue. Groups such as the United Church of Canada and the Assembly of First Nations argued that the issue has strong moral as well as international, social and economic consequences. The Canadian Coalition on Acid Rain emphasized how important it was for Canada to demonstrate its seriousness by tightening NO_x standards for automobiles. These groups expressed a desire to see a hastening of the clean up process by Canadian SO_2 polluters. The Ontario Federation of Anglers and Hunters, the Tourism Industry Association of Canada and others highlighted the social and economic consequences of continued unabated acidic precipitation.

The second day brought together specialists concerned with the economic evaluation of acid rain impacts in North America. The various approaches to the valuation of goods without market prices, such as sportfishing, were discussed and the merits and weaknesses of each were debated. The revealed preference, site-specific methods such as the Talhelm travel cost and the hedonic approaches could be demonstrated to be internally consistent and empirically verifiable. There was concern, however, about extrapolating the results from site specific studies resulting in generalizations about all fisheries affected by acid rain. On the other hand the contingent valuation approach could be a relatively efficient way of obtaining the value of resources at risk by demonstrating society's willingness to pay to avert a loss from acid rain or else society's willingness to accept compensation for its loss. A descriptive analysis of an economic model of the commercial salmon fishery of Nova Scotia further demonstrated the need for commensurate value research for the various other sectors affected by acid rain.

Data availability and requirements were identified for the hedonic, travel cost and contingent valuation methodologies. A single set of data to feed all three economic models, and thus resolve the debate over analytical techniques, would be desirable. The major difficulty with this approach would be the selection of data gathering vehicles. For example, a road-side survey would be the most cost-effective for travel data, but a mailback or telephone survey would suffice for the contingent valuation approach.

Planning reports presented by groups formed of seminar participants to recommend approaches to acid rain research for Ontario, Quebec and the Atlantic provinces brought the seminar to a close. In Ontario, where substantial effort has already been expended in researching the Muskoka-Haliburton Region, a comparison of the Talhelm, hedonic and contingent valuation approaches was recommended. Quebec was identified as a prime area for contingent valuation research, and hope was expressed that in addition to the Talhelm study coming out of Nova Scotia in 1984, a study of property values in New Brunswick would be undertaken. In general a major concern was the lack of information and analysis on native fisheries and the "existence" value of the fishery resource.

The Acid Rain Evaluation Seminar was successful in meeting its goals and objectives. It was the dedication of the speakers in preparing and presenting their papers, plus the enthusiastic participation by everyone in the discussions, that were the major reasons for this success.

In addition to the people directly involved in the seminar, we would also like to thank those who assisted in organizing the event and in particular, Paul J. Murray and Associates Ltd. Further special thanks go to Diane Boldt, Cathy Pichette, and Marilyn Henshaw for assistance in transcribing the recorded proceedings, Bruce and Carol Rigby for preliminary editing of the manuscript, and Hervé Déry for assistance both at the seminar and in reviewing portions of the transcript.

Many other people contributed to the development of this work. Their involvement has been greatly appreciated.

The views presented in this proceedings are those of individual authors and not necessarily those of the Department of Fisheries and Oceans.

Préface

Le séminaire d'évaluation des pluies acides, tenu en mars 1984, a été parrainé par le ministère des Pêches et des Océans du Gouvernement du Canada, sous l'égide du programme du transport à grande distance des polluants atmosphériques. Le Ministère s'intéresse activement aux travaux socio-économiques sur les pluies acides depuis 1980 et a terminé un certain nombre d'études sur le sujet. La majeure partie des effets des pluies acides sur les pêches se font sentir dans les secteurs récréatif et autochtone, où les prix du marché pour les ressources mises en danger par les pluies acides sont soit insuffisants soit inexistants. De plus, l'élaboration de méthodologies visant l'évaluation des dommages économiques dans ces secteurs est encore à ses balbutiements et suscite de vives controverses. Le degré d'incertitude concernant les estimations des dommages actuels exige une consultation publique sur les questions d'évaluation des pluies acides et l'obtention d'un consensus sur les méthodes appropriées à utiliser.

Le but du séminaire était de consulter des économistes fédéraux et provinciaux, des spécialistes invités et des parties intéressées aux questions des pluies acides, et de mettre au point un plan d'action pour la recherche et l'analyse socio-économiques par le ministère des Pêches et des Océans pour l'année 1984–1985 et au-delà. Le séminaire de trois jours a commencé par un examen des aspects historiques, biologiques, économiques, sociaux et politiques des pluies acides. Cette activité a été suivie d'une période au cours de laquelle des groupes d'intérêts clés, particulièrement préoccupés par certains problèmes des pluies acides, ont présenté leur point de vue et leurs craintes à propos des approches actuelles à la résolution de la question des pluies acides nord-américaines. Des groupes comme l'Église unie du Canada et l'Assemblée des premières nations ont avancé que la question avait de graves conséquences morales, internationales, sociales et économiques. La Canadian Coalition on Acid Rain a souligné l'importance pour le Canada de démontrer sa détermination en renfonçant les normes de NO_x pour les automobiles. Ces groupes ont souhaité voir une accélération du processus de nettoyage par les pollueurs canadiens de SO_2. L'Ontario Federation of Anglers and Hunters, l'Association de l'industrie touristique du Canada et d'autres ont souligné les conséquences sociales et économiques de l'absence d'une politique de lutte contre les précipitations acides.

La deuxième journée a réuni des spécialistes intéressés par l'évaluation économique des effets des pluies acides en Amérique du Nord. Les diverses approches à l'évaluation des biens sans prix du marché, comme la pêche sportive, ont été examinées et les mérites et les points faibles de chacune ont été débattus. Il a été possible de démontrer que la préférence pour les méthodes spécifiques au site comme le coût de déplacement de Talhelm et les approches hédonistes étaient logiques sur le plan interne et vérifiables empiriquement. Cependant, l'extrapolation des résultats d'études de sites particuliers entraînant des généralisations sur toutes les pêches touchées par les pluies acides a suscité une certaine inquiétude. D'autre part, l'approche d'évaluation des éventualités pourrait constituer un moyen relativement efficace d'estimer la valeur des ressources menacées en démontrant l'intention de la société de payer pour éviter une perte par les pluies acides ou d'accepter une compensation pour cette perte. Une analyse descriptive d'un modèle économique des pêches commerciales du saumon en Nouvelle-Écosse a démontré plus en détail le besoin de la recherche des valeurs proportionnelles pour les divers autres secteurs contaminés par les pluies acides.

L'accessibilité et les besoins des données ont été établis pour les méthodologies hédonistes, du coût de déplacement et d'évaluation des éventualités. L'utilisation d'une seule série de données pour alimenter les trois modèles économiques, et donc pour résoudre le débat au sujet des techniques analytiques, était souhaitable. La principale difficulté liée à cette approche serait le choix des véhicules de collecte des données. Par exemple, un relevé effectué sur le bord d'une route serait la méthode la plus rentable pour recueillir des données sur les déplacements, mais un relevé basé sur le retour du courrier ou les entretiens téléphoniques serait suffisant pour l'approche d'évaluation des éventualités.

Le séminaire s'est terminé par la présentation, par des groupes de participants, de rapports de planification recommandant des approches à la recherche sur les pluies acides en Ontario, au Québec et dans les provinces de l'Atlantique. En Ontario, où un effort considérable a déjà été consacré à l'étude de la région de Muskoka–Haliburton, les approches d'évaluation Talhelm, hédoniste et des éventualités ont été recommandées. Le Québec a été désigné comme une région prioritaire pour l'étude de l'évaluation des éventualités et on a formulé l'espoir qu'en plus de l'étude Talhelm terminée en Nouvelle-Écosse en 1984, une recherche sur la valeur des propriétés au Nouveau-Brunswick serait entreprise. En général, on s'est inquiété surtout du manque d'informations et d'analyse sur les pêches autochtones et de la valeur de « subsistance » des ressources halieutiques.

Le séminaire d'évaluation des pluies acides a réussi à atteindre ses buts et ses objectifs. Cette réussite est principalement due à l'assiduité des conférenciers dans la préparation et la présentation de leurs communications, ainsi qu'à la participation enthousiaste de tous aux discussions.

En plus des personnes directement engagées dans les activités du séminaire, nous désirons également remercier ceux qui ont aidé à organiser cet événement et, en particulier, Paul J. Murray and Associates Ltd. Nous tenons aussi à remercier tout spécialement Diane Boldt, Cathy Pichette et Marilyn Henshaw, pour la transcription du compte rendu, Bruce et Carol Rigby pour la préparation préliminaire du manuscrit, Hervé Déry, pour son concours au déroulement du séminaire et sa révision de la transcription.

De nombreuses autres personnes ont collaboré à l'élaboration de ce travail. Leur participation a été grandement appréciée.

Les opinions émises par les auteurs dans ce compte rendu n'engagent que leur propre responsabilité et non celle du ministère des Pêches et des Océans.

Opening Remarks

R. Z. Rivers

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Abstract

A fundamental principal in economics, attributed to Pareto and others, relates to how society decides to accept changes that make some people better off while leaving others worse off. In the debate over acid emissions abatement, the argument has recently shifted from the benefits of products and services produced by polluting industries versus the costs of environmental pollution, to the present day concern of the costs of emission controls versus the benefits to the physical and social environment from implementing these controls.

This fundamental change in the nature of the question being asked of policy makers has put the onus on the advocates of environmental clean-up to demonstrate that emission abatement is worthwhile in an economic as well as a social sense. Thus, it is to the question of evaluating the social and economic benefits that can be derived from emissions clean-up, that this seminar has been directed.

Résumé

Un principe fondamental en économique, attribué à Pareto et d'autres, est lié à la façon dont la société décide d'accepter des changements qui améliorent le sort de certains, mais détériorent les conditions de vie pour d'autres. Dans le débat sur la lutte contre les émissions acides, la discussion sur les avantages des produits et des services des industries polluantes comparativement aux coûts de la pollution environnementale, a été remplacée récemment par la préoccupation actuelle des coûts des dispositifs de réduction des émissions comparativement aux avantages pour l'environnement physique et social tirés de l'application des mesures antipollution.

Ce changement fondamental dans la nature des questions posées aux décideurs de politique a renvoyé la balle dans le camp des partisans du nettoyage environnemental, qui doivent maintenant prouver que la réduction des émissions est justifiée tant du point de vue économique que social. C'est pourquoi le séminaire a tenté d'évaluer les avantages sociaux et économiques du nettoyage des émissions.

I would like to make just a few very brief opening comments. I am here today largely to listen. I think today is a day in which there is going to be a lot of listening taking place. This morning I expect that you will be interested in listening to what we at Fisheries and Oceans have to say about what we have been doing in the area of Socio-Economic Research. This afternoon, you in the private sector representing public interests will have the opportunity to tell us what you think we should be doing, and into which areas we should be directing our efforts.

I will get to the agenda shortly, but I would like to start off by mentioning a fundamental principle in economics which describes very nicely the view that rational economists, as we like to think of ourselves, have of themselves. This has been attributed to a man by the name of Pareto. For the sake of simplicity I will exercise some academic privilege (in other words just short of misquoting) to put forward the point. It goes as follows:

We should not bring about a change in our society which would make some people better off only at the expense of making others worse off.

Other economists since Pareto have modified that to reflect something along the lines that it is alright to perhaps make a few people worse off as long as in the aggregate and in total the benefits outweigh the aggregate costs to society. That is something that we today call the benefit–cost solution. Now, acid rain, or more properly acidic precipitation, is caused by runaway emissions of sulphurous oxides and nitrous oxides that our scientists tell us essentially results in a lowering of the pH levels of the rivers and the lakes in this country. The scientists tell us further that the changes in pH are, either directly or indirectly, going to kill the fish that live in those water bodies. Now, there are ways of reducing the acidity of accessible lakes and rivers through liming, for example, assuming that we don't run out of limestone, which doesn't seem an unreasonable assumption. However, even with liming, the aquatic cycle of life has been interrupted, and a stocking and feeding program is required to bring those water bodies back to their original state, and that requires a lot of effort.

Going back to Mr. Pareto, one should argue at this point that the polluters are creating changes that are making some a lot worse off. Unfortunately, it has taken us a little while to figure all this out and somehow, in an apparent reverse of logic, it is us asking them to change, to clean up their smokestacks and chimneys. Again, if we go back to Pareto, in order to effect change *civilly*, we are being asked to show that more people are being affected by the bad (pollution) than the good (lower priced non-ferrous metals), through benefit-cost analysis, and that a change (reduction in emissions) is in our overall best interest.

The changes are going to cost money, putting a drain on the pocket book and purse. To justify these changes we need at least to balance the good and the bad. The costs to be borne by our population will come, for the large part, in the form of higher utility bills and perhaps increased unemployment. On the one hand, the industries causing the pollution can come up with fairly concrete, though perhaps overestimated, costs

of control numbers running into the billions of dollars. The benefits, on the other hand, are not simply economic measures. They have to be viewed from a social and cultural, an historical and a political perspective.

We at Fisheries and Oceans started four years ago to investigate the value of the resource at risk from acid rain from an economic perspective. This past year we produced a quick and dirty study which estimated that the potential value of that resource for recreational purposes alone was close to one billion dollars per year for Eastern Canada. That estimate does not include the livelihood of the guides, outfitters, resort operators, sporting goods manufacturers, etc. Nor does it include the social, economic and cultural implications of the loss of fish for our native people, nor does it include what economists and others have termed the existence value, that is, the intrinsic value of leaving our natural resources in a natural state for our use and that of our children. Then again, we must weigh the moral issue of taking away the livelihood of outfitters, say, against the livelihood of miners or metal smelters.

Those are the major concerns that have brought us here together today ... to shed some light on and discuss the approaches that are so necessary today to resolve this problem of acid rain. We look forward today to your advice and your direction. On that point, I would like to turn our attention to the agenda and the objectives that we have set for this seminar. If the broad objective of our work is resolution of the issues and the justification of a control program, then the goal of this seminar is to arrive at a set of plans for research getting us closer to that goal by the end of this government fiscal year, 1984–85, and leading us beyond that.

If we look at the agenda, we have set out the morning to give all of us an overview of the amount of biological and physical scientific work that has been going on within Fisheries and Oceans, as coordinated by John Cooley. Pierre Vachon will discuss the various aspects of the Canada/US agreement (or disagreement) on the various issues and will also discuss what has been happening of late within Canada. Dr. Tom Wise will be giving a presentation on the history of the research program to date. Gary Vernon, the Assistant Deputy Minister in the Department of Fisheries and Oceans, formerly responsible for economic and socio-economic programs, has recently moved over to Pacific and Freshwater Fisheries, where he is responsible for the bulk of the research currently taking place on acid rain. He will join us later to present a short address and to entertain questions.

PART I — OVERVIEW / PARTIE I — APERÇU GÉNÉRAL

The Bio-Physical Environment

J. Cooley[1]

Department of Fisheries and Oceans, Acid Rain Program Manager, Burlington, Ont.

Abstract

Interest in acid rain first surfaced formally in Canada and the USA in 1978 with the formation of a bilateral group of scientists to look at ways of coordinating research and exchanging information on the subject. Today, public concern is high in both countries and politicians debate the results of studies. The economics of clean-up costs and the impacts of damage on recreation and tourism are interwoven into that complex issue known as "acid rain." Unfortunately, the problem does not resolve to simple solutions and exaggeration and misinformation on this issue can damage the credibility of the available evidence.

The four major uncertainties relating to the effects of acid deposition in eastern North America are the acid loading taking place (deposition), the sensitivity of the environment, the extent to which natural resources (e.g. fish) are exposed and the toxic effects caused by the resulting acids.

Data collection associated with acid rain research is necessary for model building and this modelling can further guide research. Because of budgetary constraints, acid rain research in Canada has tended to focus where the greatest payoff can be achieved — through the resolution and refinement of predictive models. An example of this is the work on Nova Scotia Atlantic Salmon carried out by Dr. Walton Watt and his colleagues in the DFO office in Halifax. This research has clearly demonstrated the high negative correlation between levels of acidity and the ability of southwest Nova Scotia rivers to sustain salmon production.

Through this and other research efforts, the Department of Fisheries and Oceans has been able to substantiate what was feared — that tens of thousands of lakes involving several major water systems have been affected by acid rain to the point where some populations of fish have become extinct. This is likely to be the tip of the iceberg of potential impacts to Canada's valued sport fishery resources.

Résumé

C'est en 1978 avec la création d'un groupe bilatéral de scientifiques chargés d'étudier des moyens de coordonner la recherche et d'échanger les informations dans ce domaine que le Canada et les États-Unis ont commencé à s'intéresser officiellement aux pluies acides. Aujourd'hui, les citoyens des deux pays se préoccupent fortement de la question et les hommes politiques débattent les résultats des études. L'aspect économique des coûts du nettoyage et les conséquences des dommages causés aux activités récréatives et touristiques sont étroitement liés dans la question complexe des « pluies acides ». Malheureusement, il n'y a pas de solutions simples à ce problème, et les exagérations ainsi qu'une fausse information concernant cette question peuvent miner la crédibilité des données existantes.

Les quatre principales incertitudes à propos des effets des dépôts acides dans l'est de l'Amérique du Nord sont le chargement acide (dépôt), la vulnérabilité de l'environnement, le degré d'exposition des ressources naturelles (p. ex. les poissons) et les effets toxiques causés par les substances acides.

La collecte de données liées à la recherche sur les pluies acides est nécessaire pour la construction de modèles qui, à leur tour, peuvent orienter la recherche. En raison de contraintes budgétaires, les études canadiennes sur le sujet ont eu tendance à s'orienter vers le secteur où les résultats promettaient d'être les plus rentables par la résolution et le perfectionnement des modèles de prévision. À titre d'exemple, on peut citer les travaux du Dr Walton Watt et de ses collègues sur le saumon atlantique de Nouvelle-Écosse, effectués au bureau du MPO à Halifax. Cette recherche a clairement démontré la forte corrélation négative entre les niveaux d'acidité et le pouvoir des rivières du sud-ouest de la Nouvelle-Écosse à favoriser la reproduction du saumon.

Par le biais de ces travaux et d'autres efforts, le ministère des Pêches et des Océans a pu confirmer certaines craintes, à savoir que des dizaines de milliers de lacs dans plusieurs grands bassins versants avaient été contaminés à tel point par les pluies acides que certaines populations de poissons étaient disparues. Il est probable que ce phénomène n'est que l'un des divers impacts possibles sur les ressources halieutiques sportives de valeur du Canada.

I am here today to tell you a little about the biological program on acid rain research that the Department of Fisheries and Oceans has been carrying on since 1980.

The main goal of DFO is to determine exactly what fisheries are at risk, and over what period of time. This seminar will be examining ways to evaluate in economic terms what the risks mean.

Interest in acid rain first surfaced for the U.S. and Canada in 1978 with the formation of a bilateral group of scientists. They were asked to look at ways of coordinating research and exchanging information. In these early stages, the issue of acid rain was primarily ecological: what is the damage that is being done — will there be a recovery?

At that time there was virtually no public awareness. Since those formative years, the issue has taken on a far greater complexity.

Science certainly is still integral to the problem, but superimposed on this are the political aspects: public concern is high in both countries, results of studies are debated by politicians as to their meaning; and the economics of cleanup costs and impacts on recreation and tourism are all interwoven into a complex cloth we have come to know as "Acid Rain."

Our Fisheries scientists more than ever before find themselves and their work under the microscope; they are being asked to make simple predictions on incredibly complex events.

The political nature of the problem ensures that much progress and time will be lost if predictions are taken out of

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context or are not scientifically credible; and this is time we do not have. Everyone, it seems, wants bottom-line statements and figures. They want the problem simplified to this level; certainly this would make some other decisions easier, but such statements aren't credible and cannot stand up to scientific scrutiny. What's more important, we will never be able to do this.

In the remaining time I want to try and impress upon you how very complex the biological problem is; how this Department has chosen to tackle its mandate; and give you some results from our studies which I think you will find interesting.

From the beginning, we have known that most of eastern North America has lakes and rivers in areas which, because of their geology, may make them sensitive to acid deposition, which includes rain, snow, fog, dry particles, and gases. Conveniently, although euphemistically, just about everyone refers to it as "Acid Rain." However, there are four major uncertainties that dominate the Acid Rain issue:

1) The acid loading — what falls on the aquatic system;
2) The sensitivity of the lake or river to this loading;
3) The fish and other plants and animals that live in the lake; and
4) The toxic effects caused by the acid.

Let's look at each of these uncertainties briefly and individually, because they provide the focus for our research program on fisheries. The same is also true for research done in the U.S.

Acid Loading

Obviously, knowing the acid loading is critical to determining effects. DFO scientists are dependent almost entirely on DOE scientists for this information; without it our computer models are useless. They must determine what goes up (is it sulfur dioxide, or nitric oxide or something else?); how much of it goes up and where; what happens to it when it's up there; and finally, when and where it comes down.

This latter aspect has become critical in the bilateral debate, because we need data to argue that certain emissions in the U.S. or Canada need to be reduced to protect certain areas. Or, put another way, reducing the emissions in an Idaho plant by 50% won't provide the same benefit to Ontario lakes that a similar cutback would have in Ontario or Ohio. And reducing all plants by 50%, just to be sure, is a very costly option.

Lake Sensitivity

If we are to be able to make alternate and credible predictions of impact, we must know the number and areas of lakes and watersheds in all of eastern Canada. We also must know if the lakes are headwater or downstream. We must know how well the lake can neutralize any acid that might enter it. This acid-neutralizing capacity is difficult to determine precisely, even for a single watershed.

Even if you can get to the lake, there is no simple test that will give you this figure, since the soils in the watershed contribute to its ability to "buffer" acids, and influence the rate at which a lake or river can neutralize acid. However, this capacity can be inferred from a variety of chemistry measurements, which is how we have to deal with it in our models.

Some lake characteristics are relatively easy to get, for example, mean depth and mean area; however, others, such as depth of winter and summer stratification, groundwater flow, and sediment type are not; nor would it be practical to develop models that need this information. Therefore you make assumptions or extrapolations based on data you have. Every time you do this — and we do it often of necessity — the uncertainty level goes up.

Fish Distribution

The next major uncertainty is fish distribution. This is difficult, because existing surveys are often biased towards lakes with fish. As in the other examples, we can and do make judgements on the fish species likely to be present, based on where the lake is and its characteristics. This in itself isn't enough, because any assessment of damage will require you to know what the potential fish yield will be. If you get past the first two obstacles then you must consider how exploitation (in the form of fishing pressure) and management (perhaps stocking) will affect fish yield.

As you are all aware, fish distribution or their zoogeography varies considerably and this fact must be taken into account in any exercise demanding yields of fish by species.

Toxic Effects

The last uncertainty in what seems like an impossibly long list is toxic effects. Most information on the response of fish to low pH and elevated metal concentrations comes from laboratory experiments. There is considerable uncertainty as to how well these findings apply in the field. The DFO assessment uses toxicity relationships derived from both laboratory and field studies to determine whether or not certain species will persist in a given lake or stream. Of course not all fish species have the same tolerance to acid conditions. Some, like brook trout, are hardy; others, like lake trout, are not.

Damage to the fish resource can be caused by repeated exposure to acid episodes, particularly during spring melt, even though the mean chemical condition of the water body remains adequate. A statistical estimate of the probability of occurrence of such episodes can be incorporated into the analysis, but it is impossible to predict episodes in advance, owing to annual variability in weather.

While these uncertainties are impressive, we believe that the development of a regional model that will allow us to predict gross fisheries responses to known acid deposition is possible. In support of our quest for a credible and useful predictive model on fisheries effects, DFO has undertaken in the last couple of years a number of regional fisheries and water quality surveys in eastern Canada. Some results are available, but larger regional syntheses are still in progress.

Let's look at some of the lake survey data and, in particular, let's focus on one measure of lake sensitivity referred to as alkalinity. Alkalinity is a measure of an aquatic system's ability to withstand acid stress. There is agreement among scientists that any water body with an alkalinity reading of less than 40 $\mu eq \cdot L^{-1}$ is considered to be extremely sensitive to acid rain. Results from our regional surveys in eastern Canada indicate, as suspected, that many lakes are in this category (Fig. 1–5).

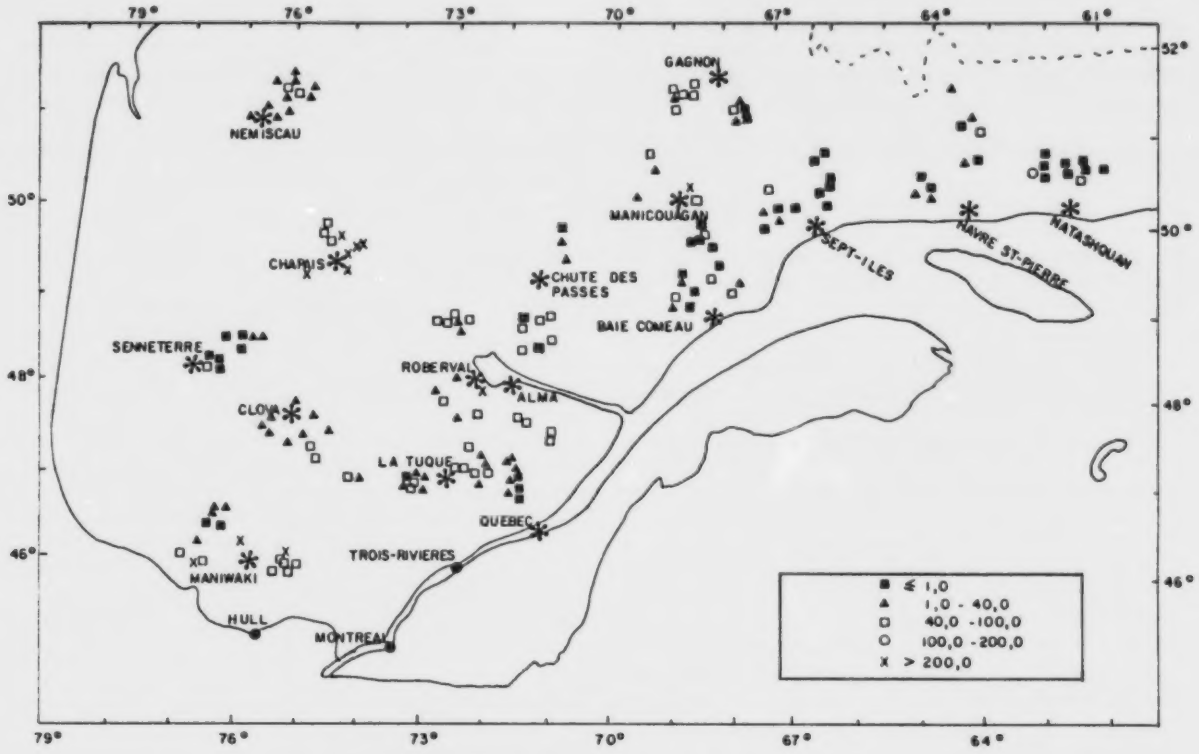

FIG. 1. Classification of Quebec lakes according to alkalinity ($\mu eq \cdot L^{-1}$). (Y. Vigneault, personal communication)

These data, it is important to remember, do not say that acid rain caused them to be sensitive, only that they are sensitive, perhaps naturally so. In actual fact, many of these systems contain brown water and are naturally acidic due to naturally occurring organic acids. Many remote lakes have probably been like this for thousands of years, but they won't remain that way if acid depositions go unchecked. We can grossly characterize the extent of the problem in Fig. 6.

Problems occur both where soils and bedrock have low potential to reduce acidity of atmospheric deposition, and where sulphate deposition is greater than 20 $kg \cdot ha^{-1} \cdot yr^{-1}$. Our judgement at the present time is that some of these systems, especially the ones with 40 $\mu eq \cdot L^{-1}$ alkalinity or less, will be affected, and so will their fish. The question is, how long will that take?

The areas of high risk are of two types:

— those that are in the most sensitive areas but currently on the average receive less than 20 kg of sulphate; and

— those that are of medium sensitivity, but receive 20 or more kg of sulphate. We would need a bilateral treaty to reduce emissions to 20 kg to protect these two areas.

Data such as these are necessary for model development. But model development also offers an important end product, and serves as a focus for guiding research. With a problem as complex as acid rain, research topics are virtually limitless, but of course, our budgets are not. Therefore, we have used our budget to support primarily those projects which contribute to the resolution and refinement of predictive models. Some of our most interesting and convincing work has been carried out by Dr. Walton Watt and his colleagues on Nova Scotia Atlantic Salmon Rivers.

Southwestern Nova Scotia, as we have seen from the lake survey data, contains some of the most sensitive water courses in Canada. It is also located in an area subject to precipitation that has tracked across some of the higher acid producing emission areas in the northeast. The mean annual pH of the precipitation which falls in this area is in the range of 4.4 to 4.6.

Surveys have revealed that a large portion of southwestern Nova Scotia no longer contains any more reproducing salmon. Watt has concluded that runs of salmon are extinct in nine rivers where the mean annual pH of the river is below 4.7. There are another 13 salmon rivers in the pH range of 4.7 to 5.0, where self-sustaining populations still exist but numbers are declining. This observation is backed up by DFO lab work in St. Andrews, New Brunswick, which has shown that early feeding fry suffer a 30% mortality rate from acidity in this pH range (Fig. 7).

There are nine more salmon rivers in the borderline pH area of 5.1 to 5.4. Watt considers these populations to be in no immediate danger. He also looked at angling success in 22 rivers going back to 1936. By arbitrarily dividing the 22 rivers into 2 groups, those with a pH above 5.0 in 1980, and those below this level, he got a striking result (Fig. 8).

Individual angling records for 6 of the 10 rivers with pH less than 5.0 are given in Fig. 9.

Mean Annual pH

Middle River	5.0	Ingram River	5.0
Tangier River	4.9	East River	4.8
Salmon River	4.7	Clyde River	4.6

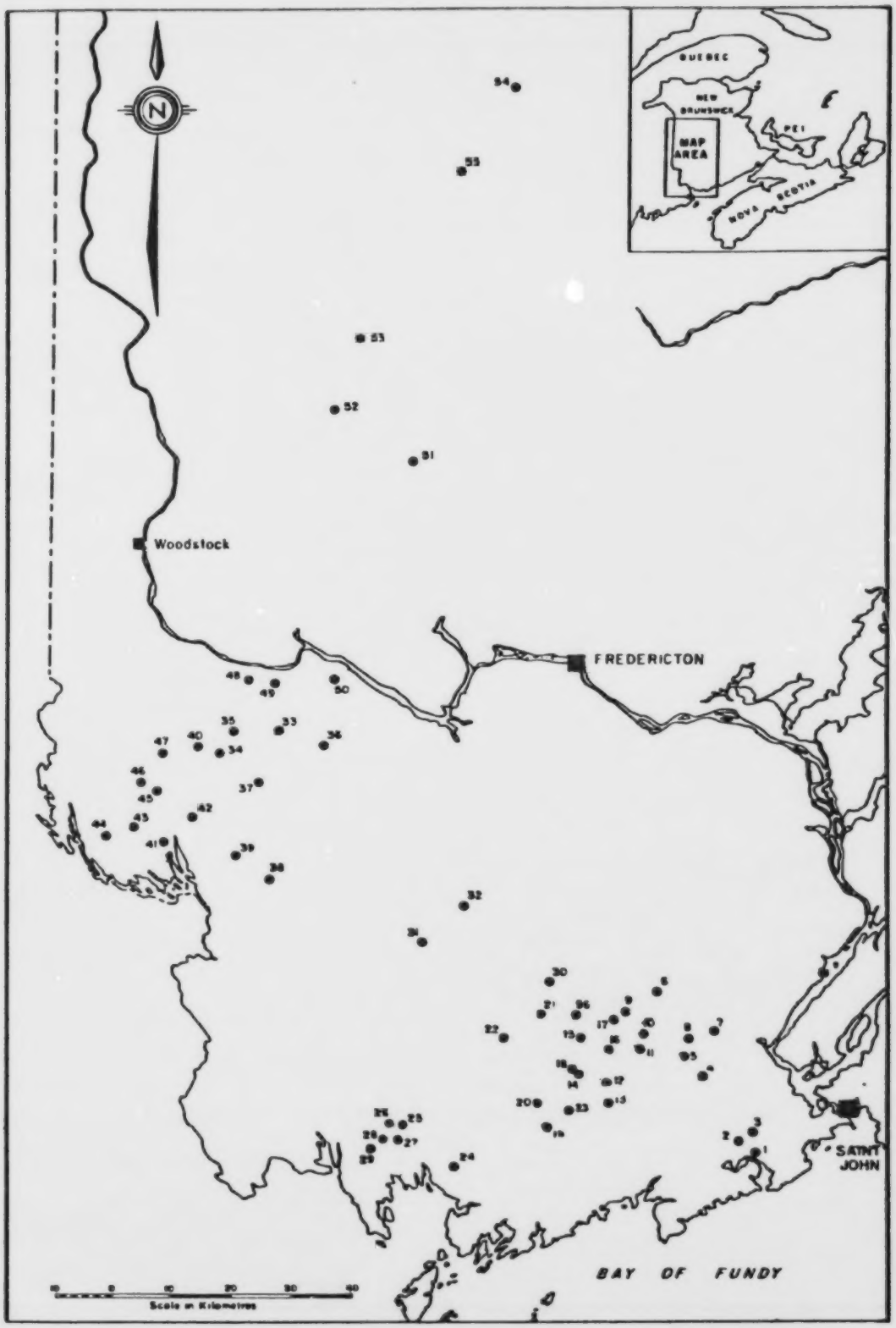

FIG. 2. Location of lakes surveyed in New Brunswick. (R. Peterson, personal communication)

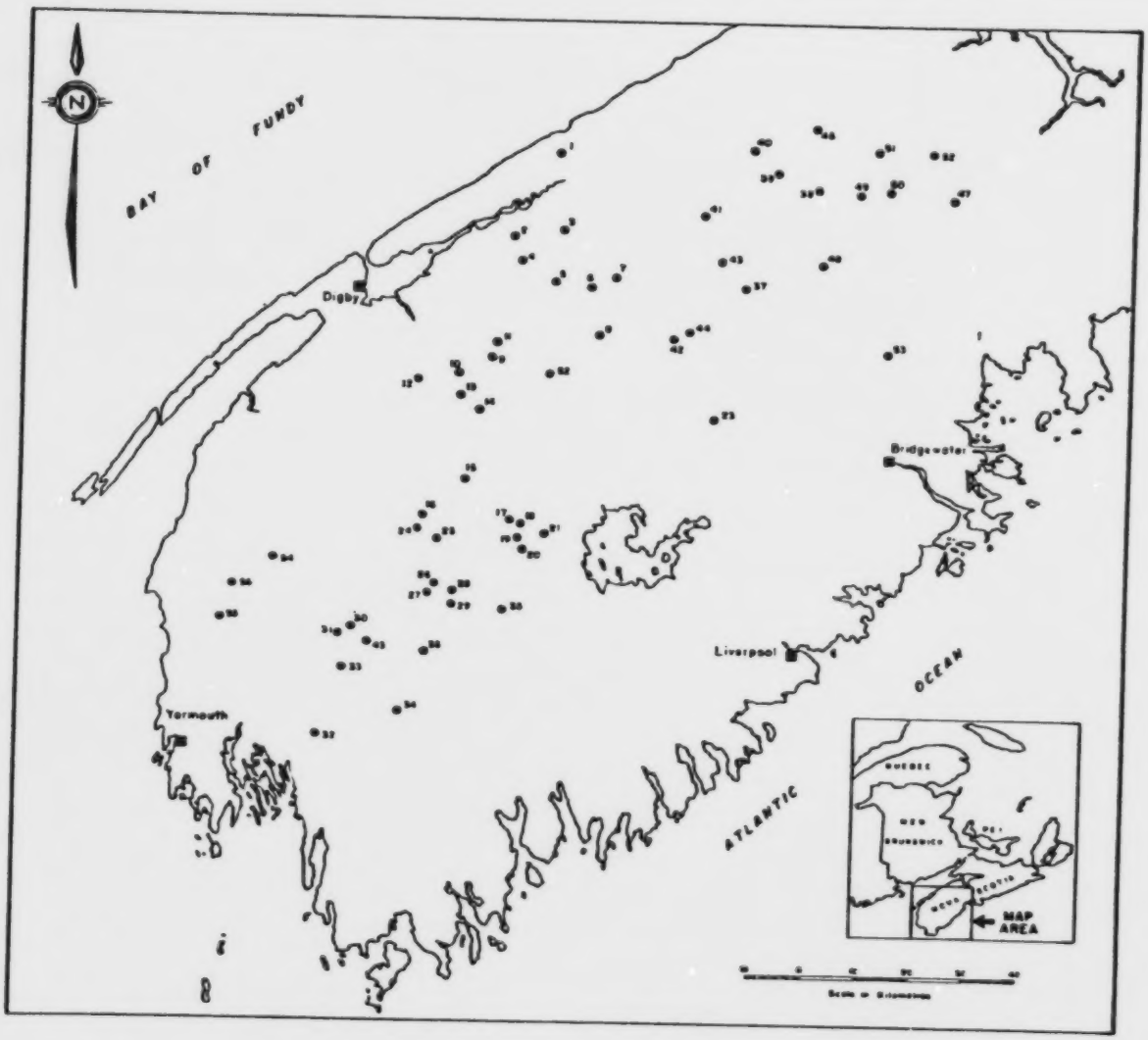

FIG. 3. Location of lakes surveyed in Nova Scotia. (R. Peterson, personal communication)

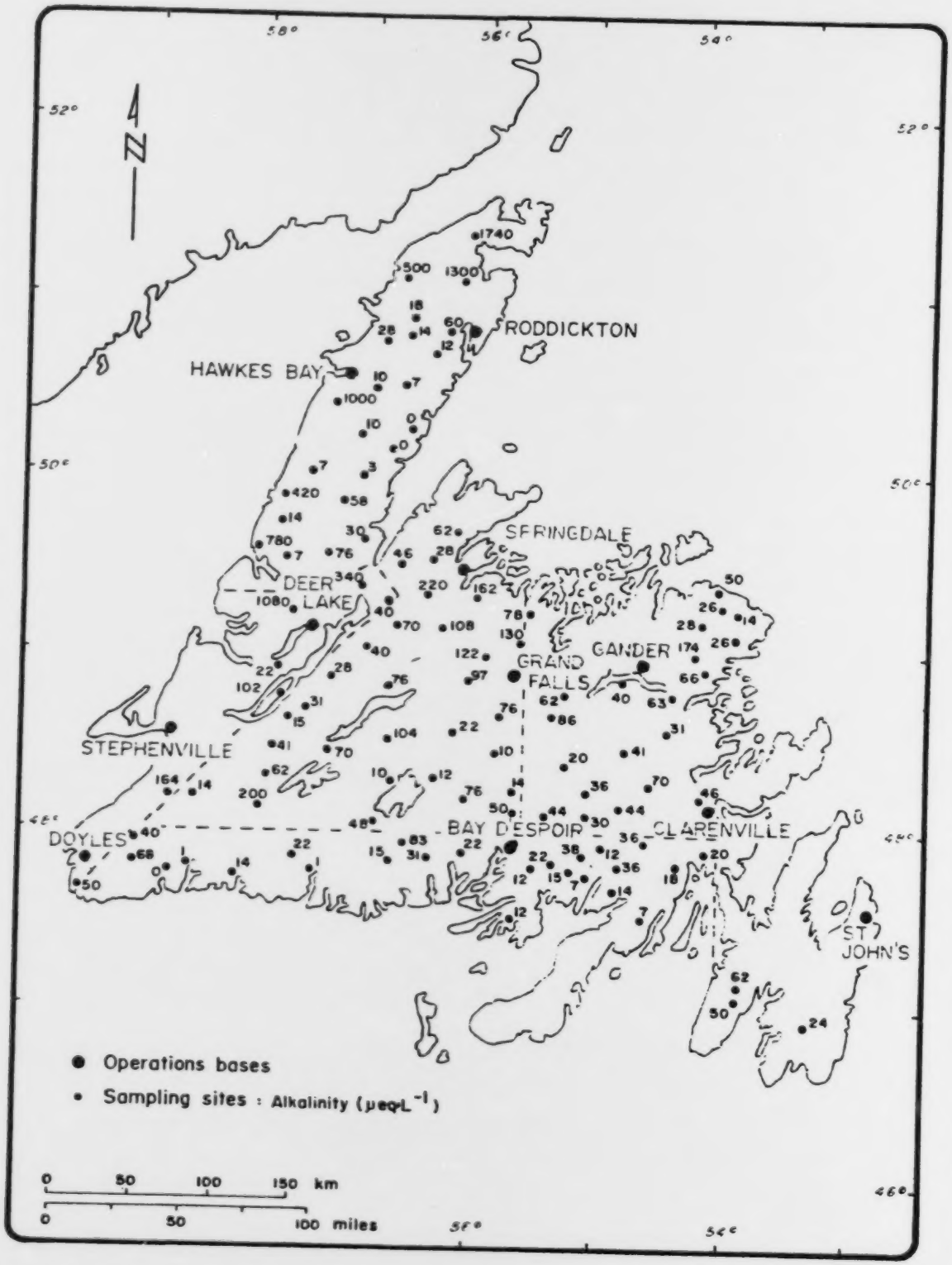

FIG. 4. Surface alkalinity determinations ($\mu eq \cdot L^{-1}$) for lakes in Newfoundland. (D. Scruton, personal communication)

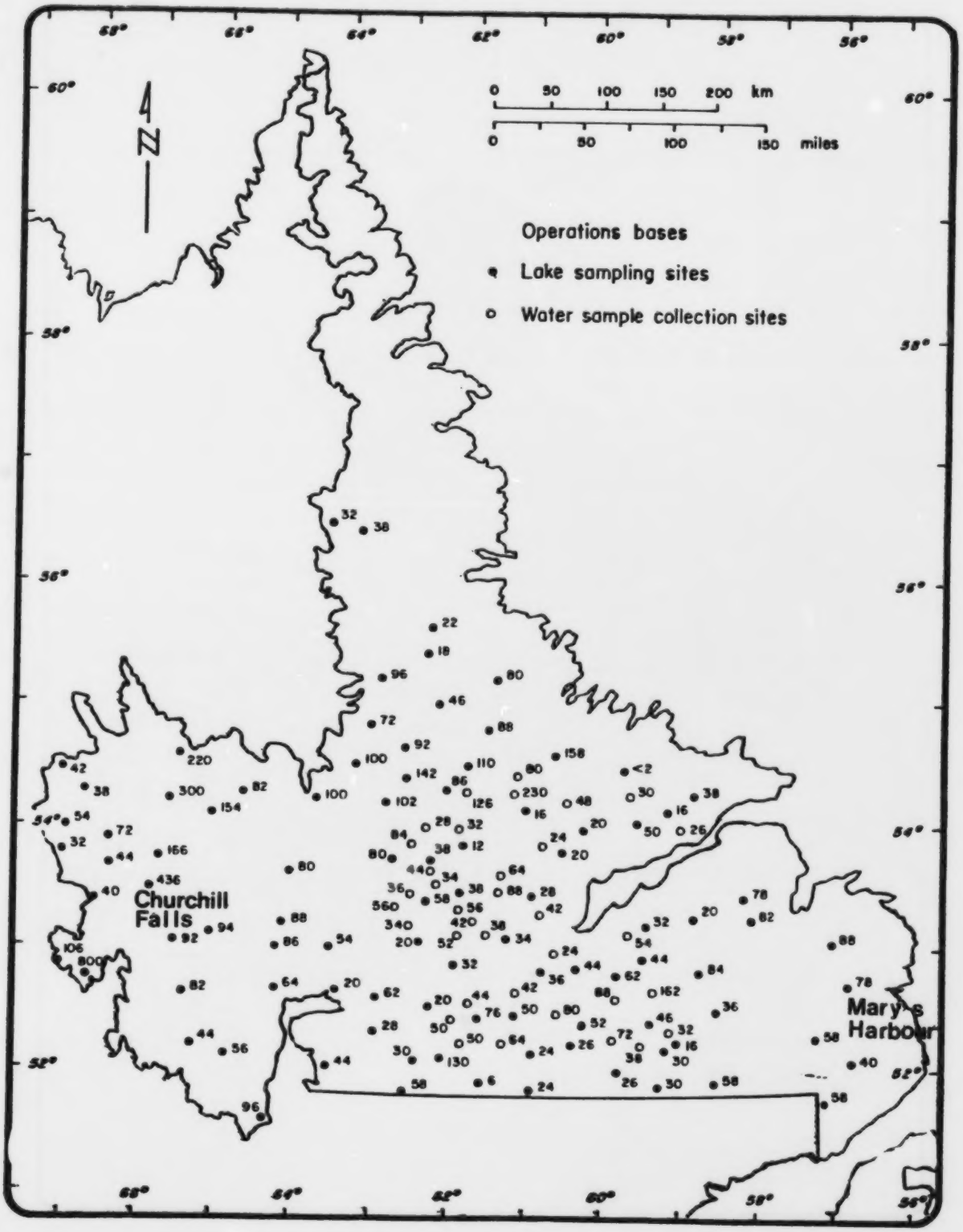

FIG. 5. Laboratory measured surface alkalinity values ($\mu eq \cdot L^{-1}$) for lakes in Labrador. (D. Scruton, personal communication)

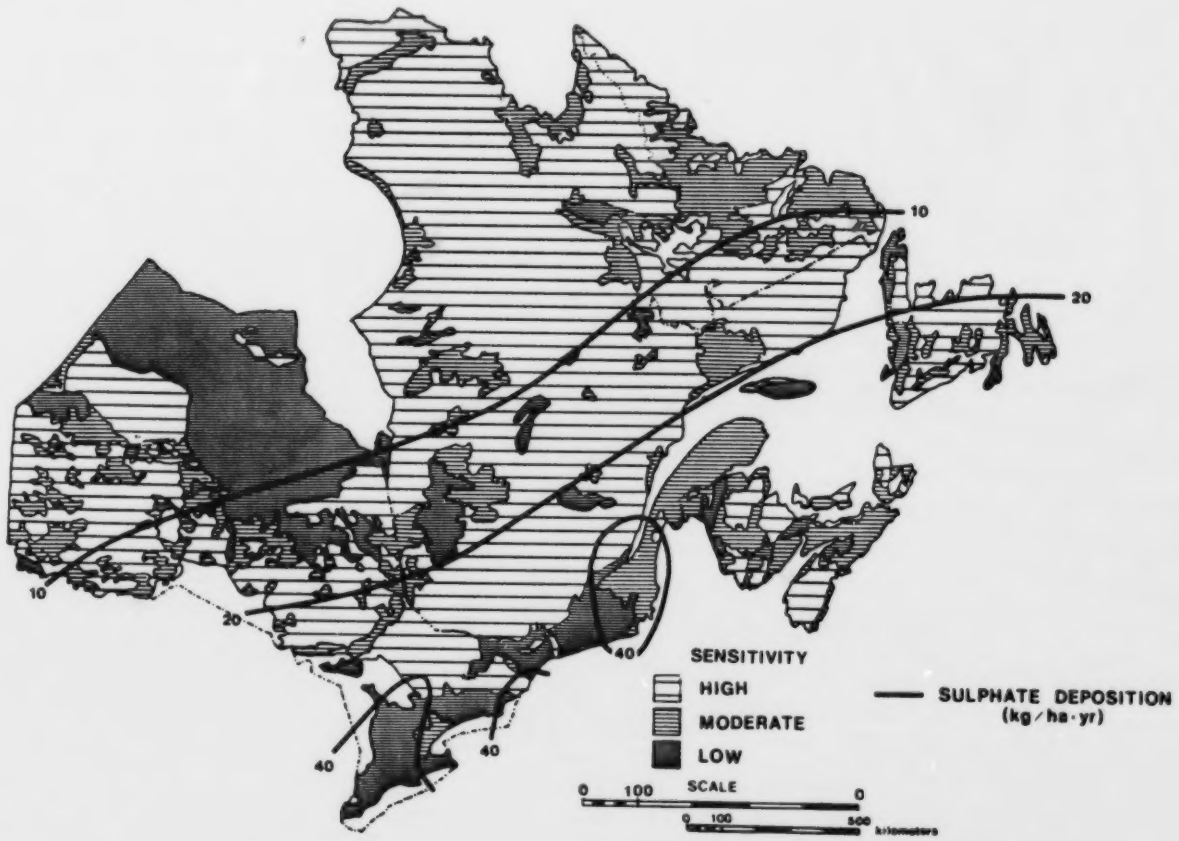

FIG. 6. Potential of soils and bedrock to reduce acidity of atmospheric deposition in eastern Canada. (G. Bangay, personal communication)

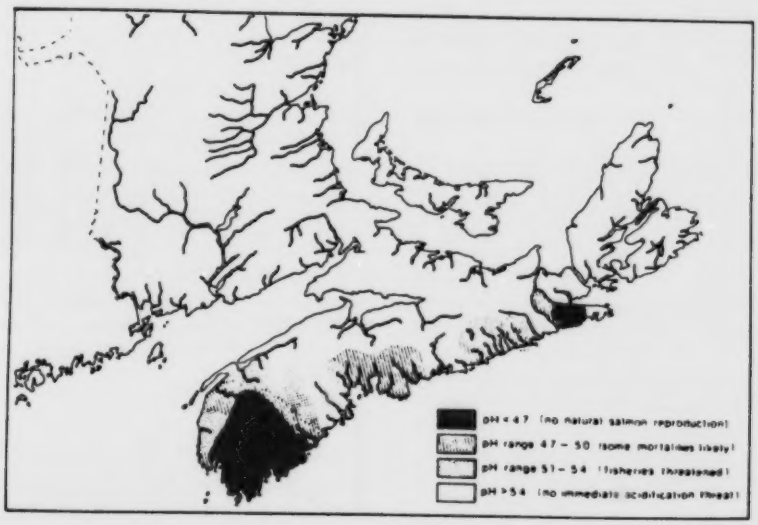

FIG. 7. The Atlantic salmon rivers of the Maritimes have been divided into four pH (estimated mean annual) categories based on significance to salmon reproduction. Present evidence indicates that salmon cannot reproduce at pHs below 4.7. Juvenile mortalities of 30% or more are expected in the pH range 4.0–4.7. Rivers in the pH range 5.1–5.4 are considered threatened. Above pH 5.4 there is no immediate acidification concern with regard to Atlantic salmon (Watt 1981).

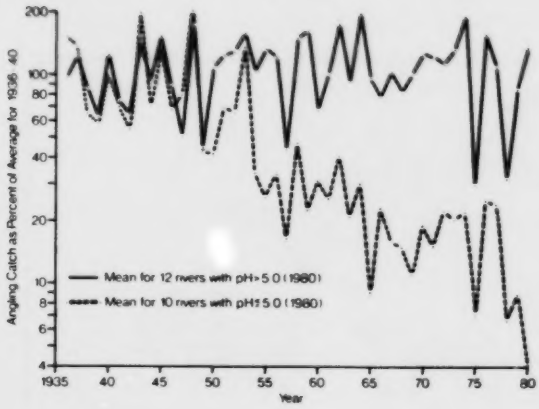

FIG. 8. Atlantic salmon angling data normalized to facilitate the comparison between high and low pH rivers. Each river's catch was expressed as a percentage of the mean catch in 1936–40 so as to give all rivers equal weighting, and the two groups were then averaged by year (Watt et al. 1983).

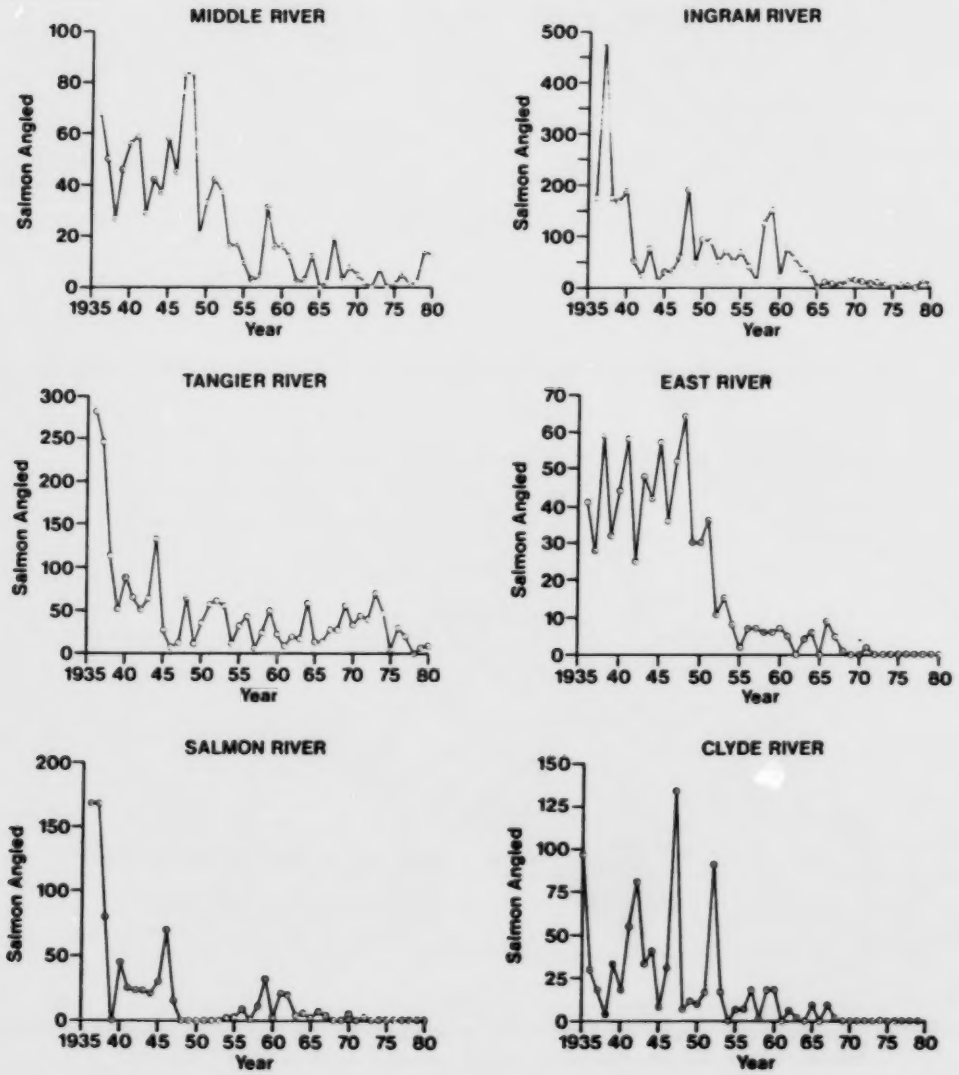

FIG. 9. Angling records for six Nova Scotia Atlantic coast rivers with mean annual pHs (1980) <5.0 (Watt et al. 1983).

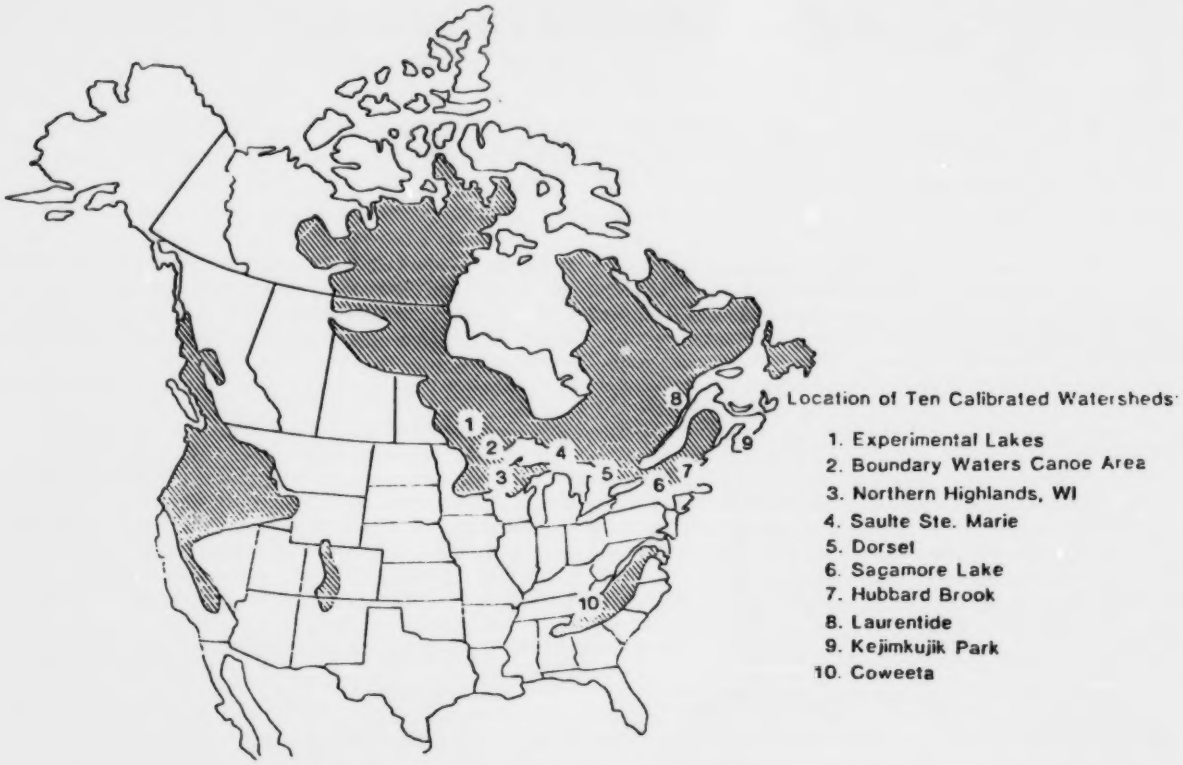

FIG. 10. Regions of North America containing lakes that may be sensitive to acidification by acidic deposition, based on bedrock geology, showing where calibrated watershed studies on sensitive areas are in progress (modified from Galloway and Cowling 1978).

Notice that the individual records for the Ingram, Salmon, and Tangier rivers suggest sharp declines in the 1936–45 period, whereas the other three rivers don't show declines until the 1950's. In association with these declines in the fishery are declines in akalinity and increases in sulphate. Watt estimates that 73% of the increase in acid is due to increased sulphate and concludes that it is due to increased acid loading in precipitation.

Another part of DFO's program involves the experimental addition of sulphate in the form of sulphuric acid to a small lake trout lake in northwestern Ontario (Fig. 10).

This experiment attempts to speed up the acidification of Canadian shield lakes over a few years instead of many. The experiment was started in 1976. Until recently, the experiment was unique, but now there are similar experiments underway in a number of other countries.

Conclusions

Since our expanded program on acid rain research began in 1980, DFO has been able to substantiate what we had feared. We now have data suggesting there are tens of thousands of lakes in areas presently receiving relatively high amounts of acid precipitation. We have produced convincing evidence indicating that some of these systems have already been affected by acid rain to a point where some fish populations have become extinct. We have every reason to believe that these sensitive systems are the tip of an immense iceberg of potential impact to Canada's valued sport fishery resource. We would be the first to admit that our knowledge of the effects is imperfect, but we do believe that more acid rain will eliminate more fish. We don't have much time before the threats become statistics.

Acknowledgments

I would like to gratefully acknowledge my colleagues in the Department of Fisheries and Oceans and Environment Canada who kindly allowed me to reference some of their data in preparing this paper. These people include: Dr. David Schindler, Dr. John Kelso, Dr. Ken Minns, Mr. Y. Vigneault, Dr. Richard Peterson, Dr. Walton Watt and Mr. Dave Scruton from DFO and Mr. Garth Bangay from DOE.

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The Socio-Political Environment

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Abstract

The acid rain program in Canada involves a number of federal departments involved with their provincial counterparts, on scientific and policy activities at both a bilateral and multilateral international level. Environment Canada, as the lead department on this issue, develops the basic strategies through the Long Range Transport of Air Pollutants (LRTAP) Steering Committee composed of representatives of External Affairs, Agriculture Canada, Energy Mines and Resources, Fisheries and Oceans, National Health and Welfare as well as Environment Canada, that chairs this committee. The purpose of this body is to act as a focus on scientific matters, giving guidance and co-ordination advice to federal departments, and providing a bridge for these activities with the provinces and other countries, in particular the USA.

While the Canadian Constitution does not specifically address environmental issues, the provinces are primarily responsible for controlling emissions that have an impact within their borders and the Federal Government is responsible for interprovincial and international air pollution. On August 5, 1980 the Canadian and U.S. governments signed a Memorandum of Intent (MOI) on transboundary air pollution. Canadian and American working groups, set up under the auspices of this MOI, resulted in published reports confirming that significant damage from sulphur deposition was occurring, and the solution was to reduce emissions. On February 5, 1982, federal and provincial Environment Ministers agreed that wet sulphate deposition should be reduced to a target level of 20 $kg \cdot ha^{-1} \cdot yr^{-1}$. It is estimated that to achieve this target both Canada and the relevant northern central and western portions of the USA would have to reduce their sulphur emissions by 50%. On February 24, 1982, this position was put to the U.S. negotiators and was rejected some months later as premature.

On March 6, 1984, Canadian federal and provincial Environment Ministers agreed to proceed independently with the development and implementation of a Canadian program of abatement resulting in a ten year reduction of the level of 1980 emissions by 50%. Reductions of 37% at the Inco Sudbury smelter, 40% at the Noranda smelters, 43% for Ontario Hydro and 40% in other non-utility fuel use applications totaling 25% overall have already or are soon to be achieved. The Canadian position has shifted from research to research and action while the USA has decided to pursue research only. While the majority of Canadian socio-economic research to date has been undertaken by the Department of Fisheries and Oceans attention must also be paid to forests, man-made structures and materials, health, and agriculture. Socio-economic activities will assume greater importance in supporting negotiations. Key social concerns, such as recreational opportunities, the livelihood of resource dependent communities, Canadian attitudes regarding unity, and general stress and anxiety levels, will play a greater role in acid rain policy decisions.

Résumé

Un certain nombre de ministères fédéraux du Canada sont engagés dans le programme sur les pluies acides et travaillent de concert avec leurs homologues provinciaux à des activités scientifiques et à l'élaboration de politiques à un niveau international bilatéral et multilatéral. En qualité de ministère responsable de cette question, Environnement Canada met au point les stratégies de base par l'entremise du Comité de direction sur le transport à grande distance des polluants atmosphériques (TGDPA), composé des représentants des Affaires extérieures, d'Agriculture Canada, d'Énergie, Mines et Ressources, de Pêches et Océans, de Santé et Bien-être social ainsi que d'Environnement Canada, qui préside le comité. Le but de cet organisme est d'assurer une fonction centralisatrice pour les questions scientifiques, offrant orientation et conseils en matière de coordination aux ministères fédéraux, et établissant la liaison pour ces activités entre le gouvernement fédéral et les provinces et d'autres pays, en particulier les États-Unis.

Bien que la Constitution canadienne ne traite pas particulièrement des questions environnementales, les provinces sont surtout responsables de la lutte contre les émissions qui exercent un impact à l'intérieur de leurs frontières tandis que le gouvernement fédéral est responsable de la pollution atmosphérique inter-provinciale et internationale. Le 5 août 1980, les gouvernements canadien et américain ont signé un mémoire d'intention (MI) sur la pollution atmosphérique transfrontière. Des groupes de travail canadiens et américains, établis dans le cadre de ce MI, ont publié des rapports confirmant l'existence de dommages considérables causés par les dépôts de soufre et établissant que la solution consistait en la réduction des émissions. Le 5 février 1982, les ministres fédéral et provinciaux de l'Environnement ont convenu que les dépôts humides de sulfate devaient être réduits jusqu'à un niveau cible de 20 $kg \cdot ha^{-1} \cdot an^{-1}$. Il a été estimé que le Canada et les régions concernées du centre-nord et de l'ouest des É.-U. devraient réduire leurs émissions de soufre de 50 % pour pouvoir atteindre cet objectif. Le 24 février 1982, cette proposition a été soumise aux négociateurs américains qui l'ont cependant rejetée, quelques mois plus tard, comme étant prématurée.

Le 6 mars 1984, les ministres fédéral et provinciaux de l'Environnement ont convenu d'entreprendre indépendamment l'élaboration et la mise en application d'un programme canadien d'antipollution ayant pour résultat une réduction de 50 % des émissions de 1980 au cours d'une période de 10 ans. Des réductions de 37 % à la fonderie Inco Sudbury, de 40 % aux fonderies Noranda, de 43 % à Ontario Hydro et de 40 % dans des utilisations de combustible ne constituant pas un service public, soit un total global de 25 %, ont déjà été obtenues ou le seront bientôt. La position canadienne est déjà passée de la recherche seule à la recherche et à l'action tandis que les États-Unis ont décidé de ne poursuivre que leurs activités de recherche. Bien que la plus grande partie de la recherche socio-économique canadienne ait été entreprise jusqu'à présent par le ministère des Pêches et des Océans, il est également nécessaire de s'intéresser aux forêts, aux ouvrages et matériaux produits par l'homme, à la santé et à l'agriculture. Les activités socio-économiques prendront une plus grande importance et viendront appuyer les négociations. Des

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préoccupations sociales clés, comme les possibilités récréatives, la subsistance des collectivités qui dépendent de certaines ressources, l'attitude des Canadiens concernant l'unité ainsi que les niveaux généraux de stress et d'anxiété, joueront un plus grand rôle dans le processus décisionnel concernant la politique des pluies acides.

The socio-political environment is the subject which I will present to you as that out of which you should be able to draw orientation and possibly guidelines for action which will be useful for the formulation of socio-economic work programs.

In my presentation I will try to persuade you that recent political decisions have considerably altered the context within which our work is to be carried out. These decisions will now require new orientation and changed emphasis in our studies. These changes will provide considerable scope for the pursuit of scientific excellence as well as the opportunity to address issues of human justice and equity.

As a prelude to my remarks, permit me first to very briefly describe my work and the structure within which I operate. This will help you understand my organizational perspective. After that I will recall, for those of you who are not as familiar as others with the acid rain issue, the chronology of events which have taken place, and that should set the perspective on the issue.

Finally, I will address our current situation as outlined earlier, and this is where I hope our perspectives will merge. At least the question period to follow should certainly help me to indentify the perspective of my audience and the extent to which we agree or disagree.

The Organizational Background

Acid rain involves a number of federal departments and scientific and policy activities. It involves federal-provincial relations as well as bilateral and multilateral concerns on the international sphere. Organizationally, these are managed as follows:

Environment Canada is the lead department, which develops the basic strategies for management of the issue. This is done within Environment Canada through an organization called the Long Range Transport of Air Pollutants Steering Committee or the LRTAP Steering Committee, and interdepartmentally through a special committee created for that purpose. The departments involved at the Interdepartmental Liaison Committee include, of course, Environment Canada, which chairs the sessions, External Affairs, Agriculture Canada, Energy, Mines and Resources, Fisheries and Oceans, National Health and Welfare, as well as those central agencies like Privy Council Office, Treasury Board and the Envelope Ministries. Although this is not a strict rule, the basic role of the Interdepartmental Liaison Committee is to focus on scientific matters and to give guidance and coordinate action among these departments. It also functions as the bridge for achieving scientific cooperation with provinces as well as with other countries, in particular the United States.

It is important to note that the Interdepartmental Committee has created a sub-committee for socio-economic studies. Environment Canada chairs this committee.

By contrast to the ILC (or the Interdepartmental Committee) where the focus is on science activities, the LRTAP Steering Committee mentioned earlier, which my boss, Bob Slater chairs, concentrates on issue management and the associated strategies for negotiations with the U.S. Administration, with provinces, the public information programs, etc.

The LRTAP liaison office, which is a group of people headed by Hans Martin, is situated within the Atmospheric Environment Service in Downsview, Ontario; it is the secretariat for the Interdepartmental Liaison Committee. Many of you, I'm sure, have talked to Hans or have seen him on the media. He's a very effective person.

The Priority Issues Directorate, where I work, is that which acts as secretariat for the LRTAP Steering Committee. In that Priority Issues Directorate there are three strategy managers who work on the acid rain issue. There's Alex Manson, who's been there for some 4 years, I think; there is Janet Davies, who recently joined us from the Minister's Office, and there's myself. We divide our focus, if you wish, on different aspects of the issue. Alex concentrates primarily upon the negotiations aspect with the U.S. and the international sphere. Janet concentrates primarily on Provincial matters and the political issues, and I look after the funding and the socio-economic area. At the moment I've been charged with the responsibility of chairing the Socio-Economic Sub-Committee of the ILC.

As you know, air pollution in Canada is a shared or concurrent responsibility of the Federal and Provincial governments. The Constitution does not talk about environment; environment matters are approached within the context of a number of constitutional headings. The provinces are primarily responsible for controlling emissions that have an impact within their borders, while the Federal Government is responsible for interprovincial and international air pollution. On August 5th, 1980, the Canadian and U.S. Governments signed a Memorandum of Intent on transboundary air pollution, which I'll refer to as the MOI from here on in. Under the terms of the MOI, and you recall this was at the time of the Carter administration in the U.S., both countries acknowledged the already serious problem of acid rain and agreed: firstly, to negotiate a transboundary air pollution agreement as soon as possible; secondly, to establish work groups to develop the scientific and technical basis for an agreement; and thirdly, to vigorously enforce existing laws and regulations in the interim. The main conclusions of the workgroups, which were published about a year ago, were that damage in both the short and the long term is occurring in areas vulnerable to acid rain as a result of sulphur deposition. Wet sulphate deposition above 20 $kg \cdot ha^{-1} \cdot yr^{-1}$ in vulnerable areas is associated with damage, whereas areas with depositions less than that have no recorded damage. As you recall from John Cooley's presentation, the same point was made there. The damage is caused, primarily, by sulphur deposition, and the solution is to reduce it. The heaviest deposition occurs down-wind and in areas around the major industrial regions. Technology exists to reduce emissions by substantial amounts. If there is no change in abatement programs, emissions are forecast to increase throughout the remainder of this century.

On February 5th, 1982, Federal and Provincial Environment Ministers agreed that wet sulphate deposition should be reduced to less than what we now call the target objective, the 20 $kg \cdot ha^{-1} \cdot yr^{-1}$, so as to protect moderately sensitive lakes and streams; and they said that to achieve this target objective, emissions in Canada east of the Manitoba–

Saskatchewan border, and in the United States east of the Mississippi River (in other words, the eastern portion of the continent) needed to be reduced by up to 50%. They added that Canada would reduce emissions by up to 50%, contingent upon parallel and compatible action in the United States, compatible in the sense that the emissions that have impact in Canada arise primarily from the midwest or the Ohio area. If the U.S. reduces its emissions south of a certain portion, it would have little impact in Canada. On February 24th, 1982, this proposal was put to the U.S. negotiators under the MOI process and on June 22, 1982, the U.S. rejected the Canadian proposal as premature.

At that point, there was a lot of reflection; should we try and pursue negotiations or should we not? Let's say that negotiations lapsed for a long period.

On March 6th, 1984, just recently, the Federal and Provincial Environment Ministers agreed to proceed independently with the development and implementation of further Canadian abatement action. They did that because President Reagan had announced in his State of the Union message that he favoured the pursuit of more research rather than taking any control action. Consequently, Canadian Ministers reaffirmed their commitment to the target objective to protect moderately sensitive areas in Canada, and they have agreed to reduce the 1980 base case of SO_2 emissions by 50% by 1994. You'll notice there's a slight shift there, from 1990 to 1994. The specifics of this reduction will be worked out by a ministerial-level working group comprising Federal and Provincial Ministers, a group which still has to be created.

Under the Federal–Provincial cooperative approach, Canada is now designing and initiating a number of actions to combat acid rain. The Canadian approach to acid deposition abatement is to determine an acceptable rate of deposition in selected receiving areas and then to estimate the ranges of reductions and emissions for contributing source areas that would achieve the environmental objective. Alternative programs will then be developed and technically assessed for those ranges for each emission area, and these will then be reviewed in relation to social, economic, energy and other factors.

Initiatives and commitments already agreed to will reduce the 1980 base case for sulphur emissions by about 25%. These initiatives include a 37% reduction at the Inco Sudbury smelter, a 40% reduction at the Noranda smelter, which still has to take place, (but I would like to come back to that in a moment), a 43% reduction at Ontario Hydro, and up to 40% reduction in non-utility fuel use emissions through natural gas conversion and fuel upgrading.

The Horne smelter in Noranda has not yet cut back its emissions; however the Provincial government, through Mr. Leger and Mr. Ouellette, the Environment Ministers, is committed to this 40% reduction and this was recently reaffirmed again on March 6th.

If we look at the impact of these reductions (Table 1), you have the kilograms of wet sulphate per hectare per year, for five of the major areas where we collect data: boundary waters area, which is at the extreme west, Algoma, Muskoka, Montmorency, not far from Quebec City, and Kejimkujik in Nova Scotia. The current deposition levels, as you see, range from, in the extreme west, between 7 and 12 $kg \cdot ha^{-1} \cdot yr^{-1}$ then they reach a high in the Muskokas of between 29 and 35. Quebec City is also very high but levels are somewhat less in the east.

As I pointed out earlier, there's a deposition reduction agreement at the Provincial and Federal levels of 25% now, and our mathematical models predict that this reduction will bring about the shift in depositions that you can see there. Basically, the Muskokas and Montmorency will benefit the most. As you go to a 50% reduction such as is planned, you see that again, while all the areas benefit, the main benefits are concentrated in the Muskoka and Montmorency areas. If Canada were to reduce emissions 100%, the model predicts that even in the Muskokas and Montmorency there would remain considerable damage from U.S. emissions. And finally, if Canada and the U.S. both took a 50% emission reduction, as you can see, almost all areas, the Montmorency area being a minor exception, would meet the 20 $kg \cdot ha^{-1} \cdot yr^{-1}$ (the Montmorency exception is within the margin of error of the model).

Now, let me turn to the points which I made earlier. First, the recent ministerial decisions, which I've talked about, and you've seen the results which we project, have considerably altered the context for socio-economic studies. Before, we were primarily concerned with U.S. negotiations, and at the negotiation table we wanted to point to the damage that the Americans were causing in Canada, as well as in the U.S., even if we recognized that the American government would be most concerned with the concerns of its own citizens. We therefore collaborated with their scientists in this field. At home we showed our firm intentions by taking unilateral reduction measures of 25% and we pursued as well an important level of scientific activities.

Now that the U.S. administration has decided to pursue research rather than take appropriate controls, and the decisions are put off for at least a year, perhaps more, we still hope to bring the parties together to negotiate; we won't relent on that. It's possible that after the election of the Presidency, the political factors may change, and the administration may see some advantages in negotiating an agreement. We must therefore still concentrate on damage

TABLE 1. Impact of SO_2 reductions (kilograms of wet sulphate per hectare per year).

	Current deposition	Deposition with 25% reduction in Canada	Deposition with 50% reduction in Canada	Deposition with 100% reduction in Canada	Deposition with 50% reduction in Canada + 50% reduction in U.S.
Boundary Waters Area	7–12	7–12	6–11	6–11	6–11
Algoma Area	18–22	17–21	16–20	14–18	11–15
Muskoka Area	29–35	27–33	24–30	20–26	13–19
Montmorency Area	27–33	25–31	23–29	19–25	15–21
Kejimikujik Area (N.S.)	17–23	17–23	16–22	14–20	15–20

(figures are approximate)

estimates for the affected Canadian areas. However, the Canadian decision to take a unilateral 50% reduction will now raise questions about who should pay, how this should be brought about, in what amounts, and will these amounts be proportionate in benefits to what would be obtained in absence of complementary U.S. action.

Secondly, changes in orientation and emphasis: to date, almost all of the socio-economic activities that have been carried out in relation to acid rain have been carried out in Fisheries and Oceans. This was natural in a sense, since more was known about dose response relationships in the aquatics and fisheries areas. Virtually no work was done in other areas until mid 83–84. From the programs' standpoint, attention with respect to forests, man-made structures and materials, health, and agriculture, must also receive attention. This does not mean relinquishing efforts in the fisheries area, for in fact, you should know that budget allocations being sought will ensure a higher level of work at DFO. But the point is, other areas must also mobilize rapidly.

Socio-economic activities will assume greater importance in supporting negotiations, because in the face of uncertain scientific knowledge, which may take many years, socio-economic information is that which can help decision makers make better judgements as to policy choices and resource allocations. At the recently held peer review, it was suggested that statistical analysis of farming accounts in low and high deposition areas could provide insight as to the effects of acid rain on certain crops, independent of laboratory work. Similar and other new approaches may be developed and applied to other resources. We do not always depend upon scientific dose–response relationships.

Social concerns such as the impact of acid rain on Canadian recreational habits, on communities dependent upon sensitive resources for subsistence and economic welfare, on Canadian attitudes regarding unity, on stress and anxiety levels, are all questions which may have an impact on policy making. These studies would also help describe who would benefit and who would suffer as this issue matures and government avoids certain actions or takes measures to correct or compensate.

Thirdly, many of these questions focus on some of those in our society who, in northern rural communities particularly, are really living close to the margin, are alienated and could lose from inaction or unjust action. Consequently, these persons are worthy of special attention. It's been said that air and water and our environment constitute a collective good of which conventional economics has not been able to take account. Distortions in the way in which the environment is perceived by the market place and reflected in economic science create problems. Acid rain could bring to this a very special focus and I feel sure that it would provide opportunities to bring about needed changes in this perception of the environment and the subsequent behavior in the market place.

Let me recap where you may wish to consider focusing some of your discussions during this seminar. First, we must support U.S. negotiations by concentrating primarily on damage estimates generally, but more particularly in areas where Canadian action is insufficient, in the Muskoka and Montmorency areas. Secondly, we must support Canadian decision-makers by concentrating on the distributive consequences of inaction as well as the corrective and compensation proposals. Finally, I suggest that we should give more importance to the social dimensions of the impact of acid rain on Canadian society.

A Progress Review of Acid Rain Evaluation Research

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Abstract

The basic problem with the benefit-cost analytical approach, that many suggest as the decision criteria for action on acid rain, is that while cost estimates of reducing acid emissions are reasonably easy to obtain and appear substantial, the benefits are more difficult to quantify. To date, estimates of these benefits have been inadequate. A further dilemma is that while on the one hand the costs of pollution abatement may be purposefully exaggerated (in the hope of receiving governmental assistance), benefits, which are not priced in "normal" markets, tend to be understated. Whereas the values of the resources at risk are measured for "users," such as sport fishermen, rarely is account taken of the value to all Canadians of the continued existence of the natural resources at risk to acid rain.

A recent study by the Department of Fisheries and Oceans put the economic value of the recreational fishery at risk to acid rain in Eastern Canada at about a billion dollars a year. However, this study did not account for the value of fish to other users such as native food fishermen. Thus, while the Department has perhaps advanced significantly in the study of acid rain impacts, there is still a long way to go and much research to undertake before we can provide conclusive evidence to our American counterparts.

Résumé

Le problème fondamental lié à l'approche analytique des coûts-bénéfices, qu'un grand nombre considère comme le critère décisionnel pour les mesures d'action concernant les pluies acides, se résume au fait que malgré la facilité relative d'obtention des estimations du coût de réduction des émissions acides et leur importance apparente, les avantages sont plus difficiles à quantifier. Jusqu'à présent, les estimations de ces avantages ont été inadéquates. De plus, bien que, d'une part, les coûts de la lutte contre la pollution puissent être exagérés intentionnellement (dans l'espoir d'obtenir de l'aide gouvernementale), les avantages, pour lesquels on n'a pas fixé de prix dans les marchés « normaux », tendent à être minimisés. Tandis que les valeurs des ressources menacées sont mesurées pour les « utilisateurs », comme les amateurs de pêche sportive, il est rare que l'on considère la valeur que représente pour tous les Canadiens la conservation des ressources naturelles menacées par les pluies acides.

Une étude récente par le ministère des Pêches et des Océans a fixé à environ un milliard de dollars par année la valeur économique des pêches sportives menacées par les pluies acides dans l'est du Canada. Cependant, cette étude n'a pas tenu compte de la valeur du poisson pour d'autres utilisations comme les Autochtones qui pratiquent la pêche de subsistance. En conséquence, bien que le ministère ait sensiblement progressé dans l'étude des effets des pluies acides, il reste encore un long chemin à parcourir et une recherche considérable à entreprendre avant de pouvoir fournir des données concluantes à nos homologues américains.

When I came into Fisheries and Oceans in 1981, I was told, "Acid rain is one of your concerns, how do you measure it, would you please tell us?" I then said, "Well, what is it and what does one do about it?" So, in the normal way of a bureaucrat, I hired the firm of Victor and Burrell to tell us what it was and what the concerns were. And they did a report, copies of which are available here, although unfortunately only in English.

Let me step back a bit and raise a basic problem about benefit–cost analysis with regard to the effects of acid rain. The costs of reducing acid rain emissions, which would have to be imposed upon the smelters in Sudbury, the hydro-electric plants of Ontario Hydro, Rouyn Noranda, and so forth are quite clear, or at least appear quite clear, and involve substantial amounts of money having to be paid for scrubbers or for other ways of reducing the emissions. If you reduce the amount of sulphur going out you have a problem: what you do with the sulphur which you then collect and how do you dispose of it? This again may impose very heavy costs upon people. There are clear cash costs which have to be paid by someone. There is a problem in that when people are first thinking about the costs they may very well exaggerate them. Particularly, of course, if you go to Inco and say "how much would it cost you to reduce the costs of sulphur emissions" and they think "well, perhaps the federal government will pay for some of this," they may well tend to exaggerate. But it may also be that they simply don't know.

IMPACT AREAS

1) Recreation and Sport Fishermen (Anglers)
2) Native Fisheries
3) Commercial Fisheries
4) Dependent Communities
5) Resource Existence

The benefits of reducing acid rain emissions are much softer and are much more difficult to state clearly. Some anglers are not able to go fishing quite as often as they might like, or catch fewer fish. In Canada, anglers, with very minor exceptions in New Brunswick and a few other areas, don't pay very much for the rights to go fishing. It is often very difficult to state how much loss is imposed upon them. There is a loss because in the areas which are particularly likely to be affected by acid rain, there are a large number of Indians living and also some people who have been living there for a long time, who depend upon the fish for part of their food, for part of their culture, or for other reasons. Again, if the amount of fish they can get goes down, it is not immediately obvious what cash costs are imposed upon them. There are losses but they are softer, that are less easy to measure, they are uncertain. There may be some commercial fisheries

which are affected; commercial salmon fisheries off Newfoundland and in the Maritimes and to some extent in Quebec depend, of course, upon the ability of the salmon to reproduce in the rivers, and if they can no longer reproduce in the rivers there will be some losses. Those are cash costs which you can perhaps estimate more clearly than perhaps some of the other ones. There are also a number of communities which are to some extent dependent upon fish that are no longer there, and if the fish are no longer there then these communities are going to be affected.

There are communities, for example in the Muskoka/Haliburton area, of people who own cottages largely because they can go fishing, and there are people who live in those communities who supply the people who live in the cottages. There are people elsewhere, who are looking after or earn their living by helping the people who want to go sport fishing, that kind of thing.

Finally, there is what we call resource existence, which I think is valued by a lot of Canadians, by a lot of North Americans, who may not necessarily fish. Although roughly three-quarters of Canadians are not anglers or do very little angling, there is a concern that we value the true north and free, we value the concept that we have unspoiled resources across Canada. If acid rain spoils those resources, this imposes psychological loss upon us, which is something which I think we all feel, we all value, we would all in some sense be willing to pay to stop happening, perhaps. Certainly we feel irritated by it happening, we wish we could somehow persuade people to stop it happening. But how do you measure that kind of concern? There also may be other concerns.

As Ray mentioned earlier, we have made a crude calculation (and when I look at it I sometimes shudder at how crude it is, but still it's probably about right), that if acid rain continues and it grows there will be a loss each year to Canadian anglers of about a billion dollars a year. This figure may be high, it may be low, but we feel reasonably confident that it's about the right order of magnitude. How do you measure the concerns of some of the other people? Can you measure for example, for the natives, the effects on their culture in dollar terms? You could maybe measure the loss of food that they would suffer when they can no longer fish for their food in some kind of dollar terms, but can you measure the other things? Are there some concerns which we have missed on that list? What we would like to hear from the people who will be talking to us this afternoon is: what are the concerns; have we got the right concerns; are there concerns which we should think about which are not on that list? And, how important are those concerns, is there some way of saying some kinds of concerns are more important than others? And finally, if it is at all possible, are there some ways of measuring those concerns?

As John Cooley and Pierre Vachon have shown, to significantly reduce the impact of acid rain on our fisheries, and on our other resources, we have to somehow persuade the Americans to reduce their emissions. The cost of reduction would be borne in a foreign country. Even in Canada we face a somewhat similar problem. The emissions from Sudbury affect Northern Ontario to some extent. They are probably more important in fact for Northern Quebec. There is a prospect down the road of major construction of Tar Sands Plants in Northern Alberta, very close to the Saskatchewan boundary. If they do get constructed, or more get constructed, we anticipate a major effect on Northern Saskatchewan and even Manitoba. There is a problem therefore that the costs of reducing emissions tend to be in one jurisdiction, in one country, in one province; the costs that those emissions impose upon people are felt in another jurisdiction. Somehow one has to balance them; somehow we have to persuade the ministers, the politicians, the statesmen, of the importance of them. I think Canadians are generally convinced of the importance. I think some Americans are convinced. President Reagan and the residents of Ohio are apparently not convinced, or not convinced that they are sufficiently important to make heavy costs of reducing emissions sufficiently worthwhile. There is a problem in that area.

SOCIAL AND ECONOMIC VALUATION

Anglers	— willing to pay — willing to travel — revealed preferences — willing to be compensated — fishing licences — relation to bio physics of sites
Native	— food value — livelihood (way of life) — community effects — culture
Commercial	— freshwater fisheries — salmon fisheries
Communities	— infra-structure — relocation — rest of Canada
Resource Loss	— overfishing at other lakes — existence value

Pierre Vachon has said that Fisheries and Oceans has gone furthest. We have unfortunately however, only partially considered in any major numerical sense, the top item, the losses to anglers that acid rain may impose. Even then we may not have done all that we should have done. We have not really started to think at all about the other kinds of losses, and this is something which we want to do in the next years. We need your advice on how to do it.

PART II — PUBLIC PERSPECTIVE / PARTIE II — POINT DE VUE DU PUBLIC

Invitation for Participation by Interest Groups

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Abstract

There are groups and individuals who are not employed in the direct service of government, but who nonetheless are concerned with public issues. These so called "pressure groups" or "special interest groups" serve a vital function in ensuring that their direct concerns are pressed upon and taken in account by the "bureaucracies" in the formulation of public policy. The predominance of economics and benefit–cost analysis in decisions on public policy of late often tends to give the impression that "political considerations" are glossed over. However, this is not the case.

The challenge in the acid rain debate is to examine those areas where economists and other social scientists have to date been unable to articulate the social and political questions.

The task of the public interest groups is to develop the language of social conscience and to articulate what can't be represented by an economic equation.

Résumé

Il existe des groupes et des particuliers qui, bien qu'ils ne travaillent pas directement pour un service gouvernemental, sont néanmoins préoccupés par les questions publiques. Ces « groupes de pression » ou « groupes d'intérêts spéciaux » jouent un rôle vital en s'assurant que leurs intérêts prioritaires exercent des pressions sur les « bureaucraties » et sont pris en considération par ces dernières dans l'élaboration des politiques publiques. La prédominance des questions économiques et de l'analyse avantages–coûts dans les décisions de politique publique prises dernièrement, tend souvent à donner l'impression que les « considérations politiques » sont expliquées spécieusement. Cependant, ce n'est pas le cas.

Le défi dans le débat sur les pluies acides consiste à examiner les secteurs où les économistes et d'autres chercheurs du domaine social ont été incapables jusqu'à présent d'énoncer les questions sociales et politiques.

La tâche des groupes d'intérêt public est d'élaborer un langage de conscience sociale et de formuler ce qui ne peut être représenté par une équation économique.

First, I would like to welcome you all here, and I would like to say that I think your discussions and your help will probably have a direct impact on how government may perceive acid rain, and indeed how they may act with regard to acid rain. A lot of people outside government, some who are described as "pressure groups" or "special interest groups," often feel that what they have to say, or their participation, or their input, is either swept aside or lost in the morass of the bureaucracy. But I have found in my experience that through osmosis or whatever, ideas do percolate in from outside. They are taken into account, and bit by bit a corpus of accepted thought on a subject is effected by people from outside. So the challenge for you today, I think, is to come up with some practical areas that we should be looking at, areas such as Tom outlined on the board here a while ago. You have a chance through the Department to influence what is going to be looked at and in so doing, what is going to be thought.

The whole of the government right now, I think, has at least tried to put an economic bias on decision-making. Government has become more bureaucratic and economic implications of government action have taken precedence over some of the other things. There is no question of that at all. The standing joke in Ottawa is that if we wanted to declare war, it would take us a month, because we would have to do all the economic analysis and benefit–cost analysis of this sort of thing. And that's in part true. You notice in government decisions, in government statements, economics, and benefit–cost plays a high role in what government tells you it is going to do and why it's going to do it. But the fact is that notwithstanding that kind of rationale, everything is glossed over by what you might call "political considerations" and politicians with their unerring instinct for what the populace wants. After all, that's why they are there, that's why they get elected, so they know what the populace wants instinctively, and that's how we get the social research in by and large. It's largely intuitive. If the politicians are right they get elected, if they are wrong, they don't.

Stressing this social aspect a little more, people suffer bodily harm, they go to jail, they ultimately even die in wars for these kind of non-quantifiable, social, if you have them, concerns. Many of you feel that way about acid rain. Now, we can quantify how much it is going to cost to clean it up, plant by plant as Tom Wise says; we have come close to perhaps quantifying what it is doing to the fisheries resource. We can speculate on how much it is going to cost the communities and direct users of the resource; but the one thing we can't quantify is the kind of emotional attachment we have to, well, what it means to be a Canadian. And what it means to be a Canadian it seems to me, is what ultimately is the hooker; it's what gets people elected; that's what gets people concerned.

Now, what does it mean? It means access to wilderness, access to wildlife, access to fresh water. Those things mean a lot to all of us in this room. If you could devise a way so that the bureaucrats, the researchers inside, could do something effective and useful in trying to come up with costs, benefits, whatever in that area, and we could work from the inside to the politicians, I think we would make a significant move forward.

So to me, that's the challenge. I would like to invite you, to

urge you to try to look at those areas in which we haven't been able to articulate even the questions. We know they are there and we all, from politicians on down, know there is an issue there. They know how to tap the well-spring of public opinion on that issue, but we haven't been able to break it down into real costs and benefits. Now, I don't know if that is very clear. I didn't propose to make a rational statement on this because it is not a rational question. But it is there. We are here because it is there. The people who apply the pressure in many cases on acid rain aren't applying it because they are worried about the costs to Inco, or are worried about the exact loss of each settlement or each sportfisherman; some of you, I am sure, never wet a line. But there is something about our Canadian ethos that is involved in all of this. I think we have to clarify that, we have to bring it to the public's and the politician's attention. So, I would invite you all to assist us in that regard.

Resource Evaluation — The Public Perspective

Abstract of Papers Presented by Key Interest Groups

Key interested organizations with specific concerns on acid rain were invited to present their perspectives and participate in a general discussion of the issues.

The Ontario Federation of Anglers and Hunters, representing 50 000 members, is a member of the Canadian Coalition on Acid Rain, is the provincial affiliate of the Canadian Wildlife Federation, and has officially requested, since 1979, a meaningful and uncompromising enforcement of sulphur emissions by industry within the province of Ontario.

In Ontario, 20% of the 2000 native lake trout populations (representing the greatest jurisdictional responsibility for this species in the world) have directly succumbed to acid precipitation. It is estimated that only half the lake trout waters in Ontario are in good condition. The aurora trout found naturally at water with a pH of 6 in 1923 and protected since 1950 was all but extinct by 1960. In Northern Ontario and Quebec, acid rain is responsible for $600 million in damage to sport and commercial fisheries.

One in two males and one in three females residing in Ontario are anglers and each spends an average of $154 on fishing equipment alone. Resident and non-resident anglers in Ontario generated about 120 000 jobs in 1978. In 1975 these anglers spent $450 million in Ontario. Eighty-five percent of the non-resident anglers come to Ontario strictly for fishing, travel 700 miles and spend $675 each.

In Northern Ontario there are 1600 lodges and resorts used 65% by non-resident anglers. By the year 2000, with unabated acid emissions, 600 fishing lodges will go under causing the loss of 6000 jobs and a $28 million loss of annual income.

The Canadian Sportfishing Institute is a member of The Canadian Coalition on Acid Rain and attempts to address issues on behalf of the 3.5 million Canadian anglers in Eastern Canada. It sympathizes with federal and provincial governments in their attempts to remedy the acid rain situation in Canada.

In January 1984 the United Church of Canada sponsored a major consultation on acid rain bringing together representatives of all the major Canadian and American religious denominations to address the question of action on acid rain.

The Churches are involved in this issue because of the belief, rooted in biblical and theological heritage, that God, having created both the earth and humanity, has left humanity with some stewardship responsibilities for natural resources. In addition, because of the long tradition of mutual reinforcement and development of the Church and industry in Western societies, the Church bears some responsibility for the interpretation of the relationship between humanity, nature, and industry.

The Canadian Coalition on Acid Rain, an umbrella organization, began its lobby efforts in 1981 and now includes some 50 member groups representing about one and one half million Canadians. Its membership includes the Canadian Federation of Agriculture, the United Auto Workers of Canada, the United Church of Canada, and the Canadian Nature Federation. It maintains a full-time staff active in Canada and the USA and it has been highly successful at publicizing the acid rain issue, including the first acid rain editorial in the *Washington Post*.

A major concern of the Coalition is that the Canadian standard for NO_x emissions of 3.1 grams per mile is well above the U.S. standard of 1.0 grams per mile for light motor vehicles. This may prove to be an embarrassment in Canada–U.S. negotiations on acid rain.

Ideally the pollutor should pay for pollution abatement although initial public assistance may be required for the smelter modernization program. While Inco has over the past 10 years reduced their emissions from about 5000 tons per day to present 1900 tons, it is still the single largest point source of emissions in Ontario and it needs to be, and can be, reduced with available technology. However, given the current debt load of that company, additional investment cannot be made. The United Church believes that there is a general consensus that the acid rain problem can't wait until the nickel market recovers. There needs to be some joint financial arrangements between the Federal and Provincial governments and the company.

Noranda, also, is not quite profitable today, and studies have indicated that the company could not financially handle the capital costs associated with a $120 million sulphuric acid plant needed to substantially reduce their acid emissions.

The Council of Elders of the Assembly of First Nations is charged with guiding Indian political leaders to carry out Indian philosophies with respect to the land and nature. Many of the problems faced today by both Indians and society at large are cumulative ones resulting from a failure to deal with the root causes over the past decades.

There is a need to make the public aware of how their cities relate to the distant places on which native life support systems depend. There is concern that new efforts at reforestation of First Nation lands will be pitted against the rain that destroys them. There is a need for a United Nations conference to take a truly global look at acid rain, particularly with respect to the possible extent of circumpolar pollution from the Soviet Union.

The Movement against Acid Rain began in the summer of 1982 and is a grass-roots organization, covering all of Eastern Canada. It was started by groups of cottagers committed to fighting acid rain. A single fund raising event permitted the Movement to donate $54,000 to The Canadian Coalition on Acid Rain. This organization, in addition to a persistent lobbying effort in the USA, was instrumental in the development of weekly acid rain weather reports. However, it is apparent that potentially significant inroads in the North American acid rain problem could be lost because the U.S. continues to point to the lax Canadian standards for NO_x emissions. Also, the Movement feels that a 10-year period to achieve a 50% reduction in SO_2 emissions, as recently announced, is too long a time frame.

The Tourism Industry Association of Canada, a member of The Canadian Coalition on Acid Rain, is the national private sector association representing the interests of some 100 000 businesses involved in the tourism industry. Tourism in Canada, an $18 billion industry, represents 5% of GNP, and provides 1.3 million jobs which is about 11% of Canada's working labour force. In 1983, a $2.1 billion balance of payments deficit on the travel account was recorded for which the acid rain problem must be partly responsible.

The Northern Ontario Tourist Outfitters Association, founded in 1928, represents the fishing and hunting lodge industry in northern and northwestern Ontario with a current membership in excess of 1000. This organization, concerned about acid rain since the early 1970's, is already feeling the effects of acid rain because lakes that the industry depends upon are dead or dying. There are 1600 licenced tourist establishments employing 15 000 full and part-time employees that depend directly on the sport fishery of northern Ontario. In 1980 over 2.8 million anglers spent close to 38 million fishing days in Ontario and spent in excess of half a billion dollars.

La Société pour vaincre la Pollution is a Montreal based non-profit citizens group, which launched a major research project on the effects of acid rain in Quebec in 1981. The group feels that it is essential for scientists get out of the laboratory to undertake field studies in such areas as the threatened Atlantic salmon on La Côte Nord of Quebec. Such an attempt, by the Department of Fisheries and Oceans, to evaluate the impacts of acid spring shock on Atlantic salmon in the Rivière des Escoumins was a move in the right direction. Although action more than research is what is really now needed, continued research to convince Americans on how serious we are about acid rain is also necessary.

The James Bay Crees, about 8500, live in eight communities in a 300 000 square kilometre area of Northwestern Quebec. About half of the family units devote the majority of their time to subsistence gathering and consequently find themselves at the top end of the freshwater food chain consuming between one quarter and one third of their protein from fish. The conclusive evidence, from Scandinavia and Ontario, of the relationship between acidification of waters and the levels of absorbed mercury in fish, the result of a complex interplay of factors, is a major concern to the Crees. While the benefit–cost approach to considering the acid rain problem has focused on the costs of reducing emissions at source and the benefits of the various aspects of the use of fresh waters, the benefits and costs of remedial action such as liming should also be assessed.

The Union of Ontario Indians, a member of The Canadian Coalition on Acid Rain, has an environment program which services about 40 Ojibway communities in Ontario with a population of 30 000. Many of the lakes fished by those communities are in a granite, non-buffered area. Over 50% of all Indian people in those communities have fished for some substantial time, and 15% of all food comes from fishing.

In addition, Indian people hold 151 commercial fishing licences which is about 14% of all those in Ontario. These licenses generated about $1 million a year over the period from 1977 to 1981. Eighty-four of those licences are in Northern Ontario landing 75% of the value of this fishery in unbuffered lakes. History has shown that when Indians have been deprived of their traditional food fishery they have substituted substantial quantities of carbohydrates such as macaroni and white bread and this has led to a decline in general health. In addition to diseases like diabetes, there is also a concern with potential heavy metal poisoning since much of the water used by these communities comes from acidified surface water. The birch veneer industries near Wawa and Sudbury have been destroyed by acid rain and SO_2 deposition.

L'Association Québécoise de lutte contre les pluies acides, a non-profit citizens' group devoted to the protection of the environment, conducted a survey on sportfishing in Quebec for the Department of Fisheries and Oceans in 1983. The preliminary findings indicate that the threat and nature of acid precipitation is well understood by the large majority of guides, tourist outfitters, and private fishing camp operators in Quebec. The majority believe that it will not be feasible to enhance fish stocks once they have become depleted.

Résumé des mémoires présentés par des groupes d'intérêts clés

Des organisations clés représentant des intérêts particuliers dans le domaine des pluies acides ont été invitées à présenter leur point de vue et à participer à un débat général sur les questions en jeu.

L'Ontario Federation of Anglers and Hunters, qui groupe 50 000 membres, fait partie de la Canadian Coalition on Acid Rain. Affiliée à la Fédération canadienne de la faune au niveau provincial, elle a demandé officiellement, depuis 1979, une mise en application sérieuse et absolue des normes sur les émissions de soufre par l'industrie dans la province de l'Ontario.

En Ontario, vingt pour cent des deux mille populations indigènes de touladi (impliquant la plus grande responsabilité juridictionnelle pour l'espèce dans le monde) ont déjà succombé aux précipitations acides. Il est estimé que seulement la moitié des eaux fréquentées par les touladis en Ontario présentent de bonnes conditions. L'omble de fontaine aurora que l'on rencontre naturellement en 1923 dans des eaux de pH égal à 6, et protégé depuis 1950, était presque disparu en 1960. Dans le nord de l'Ontario et du Québec, les pluies acides sont responsables de dommages évalués à six cents millions de dollars dans les secteurs des pêches commerciale et sportive.

Un homme sur deux et une femme sur trois en Ontario sont des pêcheurs à la ligne et chacun dépense en moyenne cent cinquante-quatre dollars pour l'équipement de pêche seul. Les pêcheurs à la ligne résidents et non-résidents en Ontario ont contribué à créer environ 120 000 emplois en 1978. En 1975, ces pêcheurs ont dépensé 450 millions de dollars en Ontario. Quatre-vingt-cinq pour cent des pêcheurs à la ligne non-résidents viennent en Ontario strictement pour pêcher, parcourent une distance de sept cents milles et dépensent chacun 675 $.

Dans le nord de l'Ontario, 1 600 auberges et lieux de villégiature sont occupés à 65 % par des pêcheurs à la ligne non-résidents. En l'an 2000, si les émissions acides ne sont pas réduites, six cent auberges de pêche disparaîtront, entraînant la perte de six mille emplois et d'un revenu annuel de 28 millions de dollars.

Le Canadian Sportfishing Institute est membre de la Canadian Coalition on Acid Rain et tente d'étudier les questions en jeu au nom de 3,5 millions de pêcheurs à la ligne canadiens dans l'est du Canada. L'organisation collabore étroitement avec les gouvernements fédéral et provinciaux dans leurs tentatives pour remédier à la situation créée par les pluies acides au Canada.

En janvier 1984, l'Église unie du Canada a parrainé une consultation majeure sur les pluies acides réunissant des représentants de toutes les principales confessions religieuses canadiennes et américaines pour étudier la question des mesures à prendre au sujet des pluies acides. Les églises participent à l'examen du problème en raison de la croyance, enracinée dans l'héritage biblique et théologique, selon laquelle Dieu, ayant créé le monde et l'humanité, a confié à cette dernière certaines responsabilités en matière de conservation des ressources naturelles. De plus, en raison de la longue tradition de rapprochement mutuel et d'expansion de l'Église et de l'industrie dans le monde occidental, l'Église est en partie responsable de l'interprétation de la relation entre l'humanité, la nature et l'industrie.

La Canadian Coalition on Acid Rain, une sorte de confédération, a amorcé ses efforts de pressions en 1981 et comprend maintenant quelque 50 groupes membres représentant environ un million et demi de Canadiens. Ses membres comprennent la Fédération canadienne de l'agriculture, la United Auto Workers of Canada, l'Église unie du Canada et le Fédération canadienne de la nature. L'organisation maintient un personnel actif à plein temps au Canada et aux États-Unis et elle a réussi à organiser une vaste campagne de publicité sur la question des pluies acides, notamment la rédaction du premier éditorial sur ce sujet dans le *Washington Post*.

Une préoccupation majeure de la Coalition est le fait que la norme pour les émissions de NO_x de 3,1 grammes par mille soit très supérieure à la norme américaine de 1,0 gramme par mille pour les véhicules motorisés légers. Ce fait pourrait créer des difficultés au cours des négociations canado-américaines sur les pluies acides.

Idéalement, le pollueur devrait assumer les coûts de réduction de la pollution bien qu'une aide publique initiale puisse être requise pour le programme de modernisation des fonderies. Bien que la compagnie Inco ait, au cours des dix dernières années, réduit ses émissions d'environ cinq mille tonnes par jour au niveau actuel de mille neuf cent tonnes, elle constitue encore la principale source ponctuelle d'émissions en Ontario, qui peut et doit être réduite par la technologie existante. Cependant, étant donné les dettes actuelles de la compagnie, de nouveaux investissements sont impossibles. Selon l'Église unie, et le consensus général, le problème des pluies acides ne peut attendre que le marché du nickel se rétablisse. Les gouvernements fédéral et provinciaux doivent conclure avec la compagnie des accords financiers conjoints.

De même, la compagnie Noranda ne fait pas autant de profits que par le passé, et des études ont indiqué qu'elle ne pouvait assumer les coûts de capital liés à une usine d'acide sulfurique de 120 millions de dollars nécessaire pour réduire ses émissions acides.

Le Conseil des Anciens de l'Assemblée des premières nations est chargé d'orienter les chefs politiques indiens dans l'application des philosophies indiennes concernant la terre et la nature. Un grand nombre des problèmes que doivent résoudre aujourd'hui les Indiens et la société en général sont cumulatifs et attribuables au fait que personne ne s'est attaqué aux causes fondamentales de ces problèmes au cours des décennies passées.

Il est nécessaire de rendre le public conscient des impacts urbains sur les régions éloignées dont dépend la subsistance des Autochtones. On s'inquiète du fait que les nouvelles tentatives de repeuplement des forêts des premières nations seront annulées par les pluies acides qui détruisent ces forêts. Il est nécessaire qu'une conférence des Nations Unies examine d'un point de vue vraiment global les pluies acides, particulièrement en ce qui concerne l'étendue possible de la pollution circumpolaire provenant de l'Union Soviétique.

Le Mouvement against Acid Rain, qui a vu le jour à l'été de 1982, est une organisation rurale couvrant tout l'est du Canada. Elle a été mise sur pied par des groupes de villageois engagés dans la lutte contre les pluies acides. Une seule campagne de collecte de fonds a permis au mouvement de faire don de 54 000 $ à la Canadian Coalition on Acid Rain. En plus d'exercer des pressions constantes aux États-Unis, l'organisation a joué un rôle clé dans l'élaboration de rapports hebdomadaires sur les conditions atmosphériques liées aux pluies acides. Cependant, il est évident que des progrès éventuellement appréciables réalisés dans la recherche d'une solution au problème des pluies acides en Amérique du Nord pourraient être compromis parce que les États-Unis continuent à souligner le manque de rigueur des normes canadiennes sur les émissions de NO_x. De plus, le mouvement est d'avis que la période de dix ans fixée pour atteindre une réduction de 50 % des émissions de SO_2, et qui a été annoncée récemment, est trop longue.

L'Association de l'industrie touristique du Canada, membre de la Canadian Coalition on Acid Rain, est l'association nationale du secteur privé qui représente les intérêts de quelque 100 000 entreprises touristiques. Le tourisme au Canada, qui est une industrie de 18 milliards de dollars, représente 5 % du PNB et est à l'origine de 1,3 million d'emplois qui occupent environ 11 % de population active canadienne. En 1983, on a relevé un déficit de 2,1 milliards de dollars dans la balance des paiements, qui est probablement attribuable en partie au problème des pluies acides.

La Northern Ontario Tourist Outfitters Association, établie en 1928, représente l'industrie des auberges de chasse et de pêche dans le nord et le nord-ouest de l'Ontario et compte actuellement plus de 1 000 membres. Préoccupée par les pluies acides depuis le début des années 1970, l'organisation ressent déjà les effets des émissions acides parce que les lacs dont dépend l'industrie sont morts ou en voie de l'être. Il existe 1 600 établissements touristiques détenteurs de permis, occupant 15 000 employés à temps plein et à temps partiel, qui dépendent directement de la pêche sportive dans le nord de l'Ontario. En 1980, plus de 2,8 millions de pêcheurs à la ligne ont consacré près de 38 millions de jours à cette activité sportive en Ontario et ont dépensé plus d'un demi-milliard de dollars.

La Société pour vaincre la pollution est un groupe de citoyens sans but lucratif, établi à Montréal, qui a lancé en 1981 un projet de recherche d'envergure sur les effets des pluies acides au Québec. Le groupe croit qu'il est essentiel que les chercheurs délaissent leur laboratoire pour entreprendre des études sur le terrain dans des secteurs comme celui du saumon atlantique menacé sur la Côte nord du Québec. Mise en oeuvre par le ministère des Pêches et des Océans, cette tentative pour évaluer les impacts du choc acide printanier sur le saumon atlantique dans la rivière des Escoumins, a constitué un pas dans la bonne direction. Bien que les mesures d'action soient maintenant plus nécessaires que la recherche, la poursuite des travaux de recherche visant à convaincre les Américains de notre détermination à résoudre le problème ne doit pas être négligée.

La population des Cris de la baie James regroupe environ 8 500 Indiens dans huit collectivités réparties sur un territoire de 300 000 kilomètres carrés dans le nord-ouest du Québec. Environ la moitié des membres d'unités familiales consacrent la majeure partie de leur temps à la cueillette de subsistance et, en conséquence, se trouvent au sommet de la chaîne alimentaire des eaux douces, leur apport alimentaire en protéines provenant du poisson dans une proportion variant entre un quart et un tiers. La preuve concluante, provenant de Scandinavie et de l'Ontario, de la relation entre l'acidification des eaux et les concentrations de mercure absorbées dans les poissons, soit le résultat d'une interaction complexe de facteurs, suscite de graves préoccupations chez les Cris. Bien que l'approche avantages–coûts de l'étude du problème des pluies acides soit axée sur les coûts de réduction des émissions à la source et les avantages des divers aspects de l'utilisation des eaux douces, les avantages et les coûts de mesures de correction comme le chaulage devraient également être évalués.

La Union of Ontario Indians, membre de la Canadian Coalition on Acid Rain, offre un programme environnemental qui dessert environ 40 collectivités d'Ojibway comptant une population de 30 000 habitants en Ontario. Un grand nombre de lacs où pêchent ces collectivités sont dans une région granitique sans effet tampon. Plus de 50 % de tous les Indiens de ces collectivités pêchent depuis une assez longue période, et 15 % de toute la nourriture provient de la pêche.

De plus, les Indiens sont détenteurs de 151 permis de pêche commerciale, ce qui représente environ 14 % de tous les permis en Ontario. Ces permis ont apporté par an environ un million de dollars de 1977 à 1981. Quatre-vingt-quatre de ces permis ont été accordés dans le nord de l'Ontario, 75 % de la valeur de cette pêche provenant de lacs sans effet tampon. L'histoire montre que lorsque les Indiens ont étés privés de leur nourriture traditionnelle provenant de la pêche, ils lui ont substitué des quantités considérables d'hydrates de carbone comme le macaroni et le pain blanc, d'où une détérioration de leur santé générale. En plus de maladies comme le diabète, on s'inquiète de risques d'empoisonnement par les métaux lourds étant donné qu'une grande partie de l'eau utilisée par ces collectivités provient des eaux superficielles acidifiées. Les industries de placage de bouleau près de Wawa et de Sudbury ont été détruites par les pluies acides et les dépôts de SO_2.

L'Association québécoise de lutte contre les pluies acides, un groupe de citoyens sans but lucratif luttant pour la protection de l'environnement, a effectué une enquête sur la pêche sportive au Québec pour le ministère des Pêches et des Océans en 1983. Les

résultats préliminaires indiquent que la menace et la nature des précipitations acides sont bien comprises par la grande majorité des guides, des pourvoyeurs d'équipement pour touristes et des exploitants de camps de pêche privés au Québec. La majorité des répondants à l'enquête croient qu'il ne sera pas possible de rétablir les stocks de poissons lorsqu'ils auront été épuisés.

Jack Craik

Ontario Federation of Anglers and Hunters, New Liskeard, Ont. P0J 1P0

On behalf of the 50 000 members of the Ontario Federation of Anglers and Hunters, I would like to thank you for the opportunity to address once again our grave concerns for the bleak future of angling and hunting in Canada, and particularly in Ontario by reason of Acid Rain. Now, in all honesty, I must confess I was reluctant, when I was first approached to be in attendance today. It involves 3 days coming away from home and from a job, 600 miles of travel, preparing a text, and all those things that go with it for what I originally perceived to be an exercise in redundancy. After all, the awesome details and the consequences of acid precipitation are well documented. To me as a layman the technology to end acid rain does exist and all that is missing is the political will to execute. Now obviously I changed my mind, and perhaps this forum will allow me to reinforce the official record of the Ontario Federation of Anglers and Hunters, which I sometimes refer to as OFAH. OFAH is a member of the Canadian Coalition on Acid Rain and we are the provincial affiliate of the Canadian Wildlife Federation. Since 1979 OFAH has officially requested, and we have politely demanded repeatedly, a meaningful and uncompromising enforcement of sulphur emissions by industry within the province of Ontario. Our resolution that we presented received a very honest reply from the Ministry of Environment in Ontario, and I quote "Acid rain is a problem in Ontario," but the resolution, they say, "fails to recognize that we are at the mercy of foreign industries as well as our own." We, I guess, and the government, are at the mercy of industries. Now I realize that the solution was oversimplified when the Standing Resources Development Committee stated a while back that the control over Inco in Sudbury is in the hands of Queen's Park. I also understand that industry and governments are intertwined in a most complex manner and that Ontario's regulatory process is at best a bargaining process in which the Provincial Government is severely outmatched. The ability of Provincial Governments to regulate international conglomerates is restricted by market forces at play and by limited expertise. I can recall as an example, back in the mid-70's when Inco in Sudbury had plans for pollution control devices, which they were prepared to install at considerable expense. But these plans were scuttled by a federal government agency, the Export Development Corporation. The Export Development Corporation at that time provided Inco with $77 million in credit for overseas projects to the end that the abatement monies were diverted to foreign expansion, and we the anglers lost again.

I realize it can be odious when it comes to comparisons as to which country destroys more of the environment, but the fact remains that Canada with one tenth the population and industry base in the United States does cause a whopping 25% of the acids damage in the USA and 50% of the damage in Canada.

When I was reading the 1980 Canadian/U.S. Air Pollution Study that ranked the major sources of sulphur dioxide in North America, I couldn't help but think it was like an Olympic event with Ontario receiving the gold, Quebec the silver, Kentucky got the bronze, and Manitoba came a close fourth.

A little bit of a fish story: the province of Ontario formerly had 2000 native lake trout populations that represented the greatest responsibility for this species of any political jurisdiction in the world. Today 20% of those trout populations have succumbed to the acid onslaught. That comes out of SPOF (Strategic Plan for Ontario Fisheries). Only half of Ontario's lake trout waters are now in good condition because nature has established narrow parameters for the existence of lake trout populations within their individual habitat; lake trout are then an excellent indicator of trouble. Where I live, between Lake Temiskaming and Sudbury, there are or were lake trout populations in lakes nestled in precambrian bedrock that contains minerals. We took studies and maps from the Ministries of Environment and Natural Resources and they showed that acidified lakes and extinct lake trout populations, 40 and more, are to be found in the northeast direction of Sudbury. In Sudbury, we know, the world's largest smelter operation exhausts contaminants from the world's tallest stack into the atmosphere where the prevailing winds are the deciding factor as to whose doorstep that garbage is going to be dumped on. The prevailing winds, both summer and winter, blow over Sudbury from the southwest to the northeast much like a funnel, and that funnel, being the vehicle that Inco has a licence to dump it's waste into, comes in my back yard. That's why I get cranked up on acid rain. I and my family have to live in that funnel. On any given day, we are either downwind from Sudbury and upwind from Rouyn, Quebec (Noranda) or I'm downwind from Rouyn and I'm upwind from Sudbury, I just can't win. I see things changing and I am no longer alone, like an owl sitting on a dry limb of a dead tree giving a hoot into an empty and dead swamp. Obviously, more people are involved.

I've got one more disgraceful fish story, near Temagami, Ontario, back in 1923. There were three very healthy lakes with a pH of six, fish were being taken by anglers, which were unusual in their colour. When given to biologists to study, they proved to be unique, and they consequently were named Aurora Trout. The Minister of Natural Resources prohibited fishing to protect and to study the Aurora Trout from 1950 on. Ten years later they did an extensive netting of the lakes and they revealed that there were only suckers left of grotesque shape. The acidity had increased ten-fold. The Aurora Trout were studied to extinction except for one small gene pool that a foresighted Ministry employee set aside at Hill's Lake Hatchery. I'm a firm believer of the statement contained in the strategic planning for Ontario's fisheries that says, "the quality and quantity of fish are a direct reflection of the aquatic habitat and indirectly the human environment." One of the most repulsive of the destructive results of human tampering has to be the poisoning, by industry, of rivers and lakes with the resulting extinction of fish populations and every living thing, including mould putrefactive bacteria.

As a hunter, I'm now voluntarily passing up black ducks

because its numbers are in decline. Friends of mine who are trappers report to me that newborn moose calves are being found dead from no apparent cause, shortly after the calving season. I've had personal correspondence with a Dr. Kostuch in Alberta, and it's indicated that acid rain is suspect for the loss of selenium in the cow moose food uptake. Be advised that a moose will consume 40 lb of browse daily. In north-eastern Ontario, that 40 lb is altered by acid rain and what's it doing? Hunters are taking it on the chin in new restrictive harvest regulations. I surely hope it's not going to be in vain.

A 10-year old federal report indicates that acid precipitation in the greater Sudbury area, per-stack days, caused an annual $150 million for health costs. In northern Ontario and Quebec, acid rain is responsible for $600 million in damage to the sport and commercial fisheries. So, in breaking this down, we know that one in two males and one in three female residents of Ontario are anglers and each spends an average of $154 on equipment alone. Resident and non-resident anglers in Ontario have generated about $120 million in direct and indirect revenue and created 20 000 jobs in 1978. Back in 1975, they spent $450 million. Allowing a 10% inflation figure, this becomes $840 million. Eighty-five percent of the non-resident anglers come to Ontario strictly for fishing. They travel 700 miles and they spend an average of $675. A 1975 study, shows that anglers spend $829 million annually in Ontario. In northern Ontario, there are 1600 lodges and resorts; the bulk of their trade (65%), is non-resident anglers. By the year 2000, with acid rain continuing unabated, we will have caused 600 fishing lodges to go under with a resulting loss of 6000 jobs and a $28 million loss of annual income. These are, to me, rather impressive social factors and I could go on and on and on. I could talk 'til 5 o'clock about acid rain.

If the USA population awareness of acid rain is peaking, then I am confident that the U.S. angling fraternity will do their part to reverse the political indifference that's being put forward. They number 345 million votes. We, members of the Ontario Federation of Anglers and Hunters, realize the problem is not as simple as two plus two, and quickly answered and disposed of. It's a problem for industrialists that can look beyond the next balance sheet and politicians who can look beyond the next election. It requires people who can look to the future of mankind. The challenge is nothing less than preservation of our species by restoring and maintaining our essential environment and that includes all factors, natural and artificial which effect the development of all living things. Surely, our greatest psychological asset should be a sense of confidence in the environment.

J. P. Cuerrier

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On behalf of the millions of anglers across Canada, particularly the 3.5 million Canadians who indulge in sport fishing in Ontario, Quebec, and the Maritime provinces, I wish to state that I fully support the activities of the Canadian Coalition on Acid Rain. Our Institute is a member of the Coalition. We agree with the position taken by the Coalition in Canada and in the U.S. The dedication of Adele Hurley and Michael Perley, the two officials with the Coalition, is most remarkable. Canadians owe a great deal of admiration for their fight in Canada, and in the USA, against acid precipation.

The Canadian Sport Fishing Institute sympathizes with our provincial and federal governments in their attempts to remedy the situation in Canada, and in their efforts to negotiate and finalize a treaty with the United States with a view to eliminating or drastically reducing the emissions of local and trans-boundary acid pollutants. At one time, authorities envisaged a reduction in the emissions of sulphur dioxide and nitrogen oxide in the order of 50%, by the year 1990. Recently the year 1994 was mentioned. This is tragic, because in only a few years, thousands of lakes will be dead, and to a point of no return for several decades. It is unbelievable that such a situation and the rate of emissions, should be allowed to continue, and that I might leave such a desolated environment to my children and grandchildren, of whom so far I have nine. Therefore, we urge our Canadian authorities to apply all possible measures to clean up the sources of sulphur dioxide and nitrogen oxide emissions in Canada immediately; not by 1994, because they might only start the process in 1993, but now. It is urgent that a treaty be signed with the U.S. authorities. Strong measures must be adopted now if we want to save our environment.

David Hallman

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The kind of economic analyses that we hope you are going to be coming out with at the end of the 3 days will be helpful to many groups, including ourselves. I am going to talk not about the economic analyses so much as the two ends of the spectrum, the conceptual philosophical basis for this kind of activity and then how we can use the kind of activity that you are engaged in as a basis for political action. In early January of this year, the United Church sponsored a major consultation on acid rain where we brought together representatives of all the major Canadian and American religious denominations to talk about how we could work together in trying to push for the reduction of acid rain. At the time of that consultation, a reporter asked me at the beginning of an interview, "What does God have to do with acid rain?"

Some of you may have that same question and are wondering why the churches are involved in this issue. There are a couple of relatively simple answers. Part of our biblical and theological heritage is a belief that God created both the earth and humanity, and that humanity has some stewardship responsibilities for nurturing, tending and caring for the earth, not exploiting and destroying it. Acid rain has been described as one of the primary threats to the environment in this age, certainly on this continent and in western Europe, and if churches are to exercise their stewardship responsibility then they can't very well ignore an issue like acid rain. A second reason for the involvement of churches is a sense of historical responsibility for some of the problems that we are encountering in modern industrial society. There has been a long tradition of mutual reinforcement between the development of western capitalist societies during many of the past centuries, and the biblical references to humanity being given "dominion" over creation. These references have been used as rationales for a western impulse, particularly since the industrial revolution, to see the environment and the earth as being created for service to humanity

and there to be exploited and used by humanity. This "master" relationship between humanity and the earth has resulted in the kind of resource exploitation and industrial development that has taken place without sufficient concern for the environment. Churches are coming to see how, historically, Christian theology has been used in some secular contexts and misused to beef up this kind of relationship to the earth, and are trying to work towards identifying a different kind of perspective that would be more faithful to what we see as the spirit of the Bible. That perspective sees humanity and creation in some sort of interdependent relationship requiring respect, care and nurturing.

I mentioned earlier the consultation on acid rain that we held 2 months ago. Copies of the final statement of that consultation are available to you (this report is appended to these proceedings). In addition to describing our understanding of the acid rain issue, it describes some public policy guidelines that we developed for the type of decision making that needs to go on, we feel, in pollution abatement programs, and then some specific political strategies for moving Canadian and U.S. governments and industry towards more assertive action.

Canadian church representatives have met with representatives of senior management of both Inco and Noranda recently to discuss the acid rain issue and have had some frank discussions with them; not getting very far, we feel, but at least making sure that they understand the concern that is expressed by our church members. Later this week an open letter will be going to President Reagan signed by the senior leaders of five major Canadian churches, supporting the recent diplomatic protest that was delivered by Ambassador Gotlieb to the State Department. I would just like to make quick reference to that letter addressed to the President.

"Acid rain constitutes a major threat to God's creation from a biblical and theological perspective. We believe humanity has the responsibility to protect and nurture the earth, not exploit and destroy it. We are deeply disappointed and frustrated that your administration appears unwilling to support measures to reduce emissions that cause acid rain. Your own White House Office of Science and Technology, as well as the U.S. National Academy of Science, have reinforced the need for action. Our churches find it a sad commentary on our age that your administration claims the lack of resources for protecting the environment through acid rain control, and yet is devoting vast sums towards the production of more armaments capable of destroying the earth. Concern about acid rain is reflected in our government's recent diplomatic protest as shared by the Canadian people, including members of our churches. One can well understand the anger of many Canadians, as we see vulnerable areas of our environment in our country damaged by acid rain coming from your country. We fully recognize that Canada has the responsibility to reduce its own emissions of sulphur dioxide and nitrogen oxides, as well as to meet with companies such as Inco and Noranda that have smelters that are major sources of emissions. Canadian churches are pressing federal and provincial governments to be more assertive in regulating those companies and to make immediate action financially possible. The churches want to see Canada's standards for motor vehicle nitrogen oxide emissions significantly tightened. Be assured that we will be placing continued pressure on the Canadian government and the provinces for specific major reductions in emissions. While we acknowledge responsibility for reducing our own emissions, we feel that our government at least recognizes the seriousness of the acid rain problem and is committed to reduce this threat to the environment as quickly as possible. We hope that the U.S. administration will change its position, and come to see acid rain control as being in its own interests as well as a responsibility to its northern neighbor."

And that's signed by the head of the Lutheran Church in the American–Canada section, the head of the Canadian Council of Churches, moderator of the Presbyterian Church in Canada, moderator of the United Church of Canada, the chairman of the Social Affairs Commission of the Canadian Conference of Catholic Bishops, and the Primate of the Anglican Church.

In addition to this kind of communication to the American administration, we are similarly communicating with politicians in the provinces and the Federal Government. A letter from the moderator of my church, the United Church of Canada, will be sent shortly to the Prime Minister in which we raise a number of concerns. We say that we have communicated with President Reagan, and we appreciated and wanted to support Canada's diplomatic protest delivered recently, but we can only maintain this position if we are convinced that Canada's position is reflected in action. We enumerate a number of serious concerns that we would want to register. We express our appreciation and support for the recent federal/provincial Environment Ministers decision to unlink Canadian action to concomitant U.S. action. We feel that it is important for Canada to move unilaterally to reduce its own domestic emissions, both for the benefit to our own environment, as well as perhaps being able to increase our leverage in negotiations by showing specific actual reductions and shaming the Americans into action. We go on to list our concerns about specific emission producers, for example Inco; we support the Canadian Coalition's report that identifies how an 86% reduction can be effected without major job loss. We go on to talk about Noranda and the serious concerns that we have with Noranda, and particularly the Horne smelter. We are anxious for the release of the report from the Department of Energy, Mines and Resources on the smelter strategy work program, so that we can start being more specific in discussions about how the financial arrangements could be effected to allow such companies to reduce emissions. The NO_x standard, of course, is a major source of embarrassment for Canada, since it is significantly higher than the American standard.

These comments are intended to reflect the seriousness with which our churches view the acid rain problem. Whether it is damage to water systems, fish supplies (a specific focus of this meeting), forests, agricultural lands, buildings, or even human health, the issue must be tackled at various levels. Your work here is tremendously important, because the argument that may carry the greatest weight, particularly with the U.S. administration, is to demonstrate the economic costs. Our role, we see on the one hand, is helping to articulate some of the theological, philosophical, and conceptual bases that would support and indeed require action to reduce acid rain-producing emissions. On the other hand, we are educating and animating our particular churches to develop more political support for the needed action. We hope the combined efforts of all of us, whether in government, industry, economics, academia or the voluntary sector, will lead in the short term to the kind of action that will eliminate the acid rain threat in the long term.

Gregg Sheehy

Canadian Nature Federation, Ottawa, Ont.

I am a staff person of the Canadian Nature Federation but I am speaking primarily for the Coalition on Acid Rain today.

For those of you who are not familar with the Coalition on Acid Rain, a bit of background may be of interest. The Coalition, which began its work in earnest in 1981, has grown each year since, and it now includes some 50 member groups representing about one half million Canadians. A great strength of the Coalition lies in its large numbers and the diversity of its membership. Its members include: the Canadian Federation of Agriculture, the United Auto Workers of Canada, the United Church of Canada, the Canadian Nature Federation, and several of the groups represented here today. The Coalition maintains a full-time staff which is active both in Canada and the U.S. I think that perhaps one of the greatest accomplishments of the organization has been its work to publicize the acid rain issue. The Coalition was responsible for the first acid rain editorial in the *Washington Post*. That may sound like a strange accomplishment, but I understand it was very significant in raising American awareness of the issue. As well, the Coalition helped get the acid rain issue on the agenda of a number of the major American conservation groups, and the Coalition staff has a very busy schedule of speaking engagements across North America. They provide much of the direction for the individual efforts of member groups. One important public education effort of the Coalition took place last summer. This was a joint project with the Ontario Ministry of the Environment to distribute Acid Rain information request cards aimed at American fishermen. These cards were distributed through some 2000 fishing licence outlets throughout the province of Ontario.

Among our current concerns is the NO_x standard. We are pushing very strongly to have something in line with the American standard, which is 1.0 grams per mile, while we are currently at 3.1 grams per mile for light motor vehicles. As well, we hope to see a smelter modernization program, with some government support to initiate this program on a nationwide basis. And we were pleased to see the recent announcement by the Environment Ministers that Canada would go for a 50% reduction, independent of American efforts; however, we remain skeptical of the commitment because there haven't been very many specifics outlined to date.

I would also like to make the point that we recognize the significant contribution that the Department of Fisheries and Oceans has made to the fight against acid rain. The experimental lakes program, which is probably unique in the world, is really a vital part of the Canadian scientific effort. Now, these studies are providing evidence to support our concerns about lake acidification, and some of the activities you heard described about Eastern Canada are providing some good information to back up concerns about long-range transport of pollutants. Fisheries and Oceans is also playing a really important public education role. The Coalition has used brochures the Department has produced, both in Canada and in the U.S., and we feel that they make a good and defensible argument in favour of dealing with the problem of acid rain. But, given the importance of the acid rain issue and what we feel is the proven commitment, and the value of the program of the Department, we find very distressing these recent rumours of a cutback in funding for the Department's programs. These needed funds have not yet been re-authorized by the Cabinet Committee on Economic Development and it is getting quite near the end of the fiscal year; the decision on funding certainly must be made soon. In the light of this uncertainty about budgets, we somewhat question the purpose of today's seminar. Perhaps we are discussing some programs which may not even be continued. Can the Department tell us what effect these cutbacks or this questionable reallocation of funds will have on the current acid rain program? Will the experimental lakes program be cut back or discontinued? It has been going on for quite a number of years. We understand that it is intended to continue for another five years. And what will be the impact on other programs of a cutback in funds? What about your other long-term scientific efforts?

In the past 3 years, the Coalition on Acid Rain has had very regular contact with American government departments and members of Congress in the U.S. and I think you can be assured that the Americans are increasingly aware of the degree of commitment to an acid rain clean-up in Canada. The anti-controls interests are becoming increasingly skeptical and more and more aware of what is being done here. So I would definitely like to make the point to your Minister and other members of Cabinet that before any decision is made on your budget reallocation, consider that the Reagan administration has just increased the American acid rain research budget from $27 to $55 million.

Wallace LaBillois

Resident Elder, Assembly of First Nations, Ottawa, Ont.

In 70 words or less I will try to give you an idea of what my job is. My job as chairman of the Council of Elders is to specifically guide our Indian political leaders, to carry out our philosophies with respect to the land and nature, and in order to carry out this task, I must become involved in many issues, including the environmental issue. I would hope that as an individual I would never reach a hopeless state whereby I would wish that we would experience another ice age purely to clean up our own environment. I've given this a lot of thought for a long time, and really and truly, it has always been my belief that this is the only way we are ever going to clean up the environment.

It's an honour to be here with you today, even though we are gathered to consider a crisis which I can only describe as a plague which is besetting the land from which all life springs. First Nations view acid rain as a threat not only to your survival but ours. We've been ignored for too long and are glad that you have given us this opportunity to voice our concerns. A few short years ago we would not have bothered to have had a conference such as this, and if the Department of Fisheries and Oceans had convened a group of experts such as yourselves, they would certainly have not bothered to invite the Assembly of First Nations. From that point of view, then, I should like to think that we have taken the first steps in a long journey towards cleaning up our environment in general, and dealing with the plague of acid rain in particular. We've all heard the many comparisons that have been made between the economic climate today and the economic climate of the 1930's. If my grandson were to ask me what are the differences, given the similarities which we have heard described in such depressing terms, I would have to tell him that in the 1930's we relied on common sense to find ways to survive. Today, we are looking to dollars and cents. We are looking to throw more and more money at the problems without seriously considering what their causes are. I know that the problems were not considered all that well at that time

either. Many of the problems which we are facing today, including acid rain, are cumulative problems that have piled up because we failed to deal with root causes over the past decades.

I am not opposed to using monies to deal with problems if we are really going to come to terms with them. But when the money is used to add insult to injury, then we need to stop and think. I believe that acid rain and massive airborne pollution in general, epitomize the growing distrust of governments. Rather than looking to our common institutions to solve problems, we have come to see these institutions as the source of the problems, and that is really very tragic. Because the fact remains that the only solutions we will find necessarily involve making these institutions work for us.

Let me tell you a very sad story which will illustrate what I mean by throwing dollars and cents at a problem rather than common sense. There is an Indian reserve which is probably the closest reserve to Ottawa. It's Mohawk name is Akwesasne. The Jesuits and the government have called it Saint Regis. It consists of islands and shorelines along the St. Lawrence on both sides, but especially on the American side where rains flow down from the Adirondack Mountains. Cornwall Island is an incredibly beautiful place. It is what one spiritual leader from Akwesasne called "really a creator's place." That island was one of the most fertile pieces of land on this continent. It had forested areas. It grew all kinds of fruits and vegetables. Cattle grazed on it. Deer and other large wildlife came across the ice to the island in the winter.

Cornwall Island is directly in line with a huge smelter on the American side, an aluminum works. The contamination carried downwind from that smelter lands on the grass, vegetables and trees. It has turned that creator's place into a desert. The vegetation keeps on growing on the island, but the cattle that eat the grass and grain are dying. And those that do not die lose their teeth or they have abortions. And while the Department of Agriculture has verified that these narrow leaf plants are dangerous to cattle, the Department of Health assures us that the broad leaf plants are really all right for our children to eat. Well, the farmers who live on the island are also parents and they find it a little hard to believe that the rain that falls on the grass is somehow different from the rain that falls on the cabbages.

The smelting company has accepted responsibility for the contamination. They admitted that the bulk of the contamination falling on the island came from their plant, but I think that their attitude to fulfilling their responsibility does categorize the way in which we have dealt more generally with the problem of acid rain. They proposed to compensate each farmer for each cow that died, and for each calf that was aborted, and meanwhile, they would continue to churn huge amounts of contaminants into the atmosphere.

There used to be an expression to the effect that "it depends whose ox is gored." Today, we have to face the fact that the ox that is being gored belongs to all of us. How does a city feed itself if the countryside surrounding it cannot supply its needs? What is so much worse than turning the island of which I spoke into a desert, is that the results of the damage are not immediately evident. Our people experienced a similar problem with mercury pollution, when whole villages began to produce the symptoms of Minamata disease. Ten years ago, the government of the day pretended not to know there was a problem. This was the example I had in mind when I stated that ten years ago you would not have had a conference such as this and if you did, we would not have been invited. One old trapper said that when he was told his people should not eat the fish in the English and Wabigoon Rivers any longer, he did not believe it until he saw a dead otter floating downstream. It is this very state of disbelief and incredibility which we most need to confront if we are going to fight the problem of acid rain. We need to make the public aware of how their cities relate to the distant places on which our life support systems depend. The worker and the executive in Toronto need to feel a responsibility for what comes down on the Inuit of Frobisher Bay.

The Assembly of First Nations has been working with the Canadian Forestry Service and the Department of Indian and Northern Affairs to prepare a plan which will provide for the reforestation of First Nation lands, to train First Nations people as foresters, and to enable our communities to start towards economic self-sufficiency. A program such as this is a long-term project. Time is essential in making progress and that same time is needed to provide the training which will allow our people to combine their love for the forests with the best of modern know-how. It will be that combination of feeling and know-how which will make things work.

But if our labour is going to be pitted against the rain that destroys, then we are all in the same position as that farmer who was told that the smelting company would buy up his aborted calves. We do not want to be in a business of planting trees that will not grow. We must look to the future, to our grandchildren, and come to grips with acid rain. I began by talking about an island. You know the famous passage, "No man is an island entire of itself. Every man is a piece of the continent, a part of the main." What else can I tell you here today, except to remind you of what you already know? You already know that we have just come from a First Ministers' meeting on aboriginal and treaty rights in which the Federal government agreed for the first time, that they were prepared to consider some form of recognition of self government for the First Nations of this land and the provinces were not. I think the problem of acid rain represents the outer limits of a concept of sovereignty or self-government. And I am not referring only to self-government of our own First Nations. It represents the outer limits of the sovereignty of every people, great and small.

There is no doubt that the United States has been under a great deal of pressure from our government to take some real action and no longer content themselves with a further study of acid rain. I think both Canada and Ontario are to be commended for their stands they have taken and the effort they have made to confront the United States government on acid rain. But there is a need to go much further, there is a need for a United Nations conference to take a truly global look at acid rain, and such a conference cannot be a substitute for strong action. It must be a way to inspire action and to insure that the actions of each state are coordinated with those of its neighbours. While we are rightly concerned about contamination from the United States and are prepared to pull up our socks to set an example, are there any figures about our circumpolar pollution from the Soviet Union coming into Canada? There are two conditions that are essential as basic social attitudes to dealing with the global problem of acid rain. First, there is what Thomas Berger, in his report on the MacKenzie Valley, called "a need for a policy of restraint"; and secondly, there is a need for an attitude of coexistence.

Let me touch on these two attitudes as I close these remarks. A policy of restraint, as I conceive it, is not an

attitude which denies our needs, but which sets out about meeting them in the spirit of economy and efficiency. It is not opposed to development but it wants to ensure that the development it promotes benefits the local, federal, and global communities. And this is what leads it inevitably into a policy of coexistence.

What do I mean by coexistence? If it is a term which you heard third world powers using in the context of disarmament, the meaning in that context and the meaning in the context of acid rain are not too far apart. In the context of acid rain, I would sum up coexistence and restraint together by saying: they are policies based on a sustained awareness that "we are all upstream or upwind from somebody else's fishing ground."

In closing, let me tell you about an old Indian prophecy that says that when the visitor is no longer able to devour our people he will turn on his own people. I have seen many signs that suggest a policy of restraint is slowly finding acceptance and that this prophecy does not need to be fulfilled. I believe the willingness with which Canada and all neighbours confront the issue of acid rain will be the most fundamental test of whether this prophecy can be set aside for the time being. Remember, the Creator has given us this great land to live in harmony with. If we and the land are to survive, we must resolve to end the plague of acid rain together.

With this in mind, the First Nations of this country are prepared to offer their support and are willing to help in any way we can to end the problem of acid rain. It is with optimism and good will that the First Nations look forward to further dialogue and positive solutions which these three days will produce. The next generations are our future. For them we must preserve nature; for who is man without nature?

David Lawrance

Movement Against Acid Rain, Mississauga, Ont L4V 1S6

The Movement Against Acid Rain is a grass-roots organization that began in the summer of 1982, when a group of concerned cottagers decided to get together to organize to fight the issue. The group worked through the fall and the winter preparing a fund-raising and publicity-oriented event. On May 9th, 1983, the Movement's inaugural dinner was held in Toronto. The keynote speaker was the Canadian Ambassador to the United States, Ambassador Alan Gotlieb. The National Film Board's *"Acid Rain: Requiem or Recovery?"* was also shown. That dinner went far beyond our initial expectations; it attracted 800 people at $100 a plate, and a great many more who could not attend generously donated funds. In total, the one event allowed the Movement to donate $54,000 to the Canadian Coalition on Acid Rain so that they could continue their work at home and in the United States.

Our membership is drawn from the Toronto region, Muskoka, Haliburton, the Kawarthas, Quebec, Nova Scotia and we have some thirty-odd members from the United States. The inaugural dinner was just the first of the Movement's activities. Since the spring of last year, members of the Movement's organizing committee have met with and made submissions to the federal Environment Minister, the Honourable Charles Caccia, and the provincial Environment Minister, the Honourable Andrew Brandt. As late as last week, the Movement made a presentation before the Federal Sub-Committee on Acid Rain when it was in Toronto.

The Movement was instrumental in organizing weekly acid rain weather reports with the assistance of the federal and provincial environment Ministries, and the purpose of these weather reports is obvious. High acidity levels in rain, snow, fog and dry deposition are not easily detected by the average person. The impact of increased acidity levels occurs at a rate that often is not noticed until it is too late. By publishing this information in layman's terms, we are trying to promote public awareness of the causes and impact of this serious pollution. Acid rain weather reports are currently reported on radio and by newspapers. The Movement is approaching local television to include this information in their own weather reports. And similar acid rain index programs are being aired in a number of locations in the United States with great success.

The Movement has also been active in the United States. We've sent two delegations to Washington to meet with similar organizations, as well as with members of the House of Representatives and with the Senate. Our delegates have met with supporters of legislation to curb acid rain and with members of both houses who oppose further legislation that would control SO_2 and NO_x emissions. So we have in fact heard our opponents' arguments first hand. In addition, the Movement sent delegates to the recent Acid Rain 84 Conference in Manchester, New Hampshire. I was fortunate to be one of the delegates. Acid Rain 84 attracted individuals and groups from across the United States and it included roughly some 35 Canadians. The conference was an overwhelming success and was responsible for making acid rain an issue in the current race for Democratic Party nominations. As an aside, I would say it's unfortunate but predictable that the press that has been given to this issue in the Democratic race has declined.

The Movement Against Acid Rain will continue to meet with officials in both countries to promote the acceptance and speedy implementation of legislation that would bring the acid rain problem under control. So on behalf of The Movement I'd like to raise two issues as I stand before you today. First, our primary concern is Canada's lax NO_x standard. The continuance of the Canadian standard of 3.1 grams of NO_x per mile compared to the U.S. standard of 1.0 grams per mile is more than an embarrassment to Canada.

It has been and it will continue to be a hindrance to any discussions we have with the Americans. On both occasions that the Movement sent delegations to Washington, the difference between the Canadian and American emission standards was pointed out. Both opponents and proponents of stricter legislation advised our delegates to modify our own NO_x standard before expecting the United States to act in a substantial manner.

As a delegate to Acid Rain 84, I was made painfully aware by our American allies that our own position is hypocritical. At present, automobile engine plants operating in Canada are producing engines with three different standards. Engines are being built to meet the California emission requirements, the U.S. national requirement and the Canadian requirement. Of the vehicles assembled in Canada, 82% are shipped to the U.S. for sale. Each one of these vehicles is more efficient than those that remain for sale in Canada, and this makes very little sense. The U.S. House Committee on Health and the Environment received testimony during the 1981/82 session that the cost to upgrade emission standards

would range from $40.00 U.S. to a maximum of $300.00 U.S. per vehicle, depending upon the make. The mean figure is $108.72 U.S. per vehicle. Now this represents less than 1% of the cost of the vehicle. If you accept the notion that the pollutors should pay, and that there are significant benefits to be had by tightening our NO_x standard to meet that of the U.S., then this extra cost per vehicle becomes insignificant.

On Tuesday, March 6, 1984, the Honourable Charles Caccia announced that Canada would unilaterally reduce its SO_2 emissions by 50% by 1994. This is a significant step forward.

The Honourable Andrew Brandt was quoted in the *Globe and Mail* on Wednesday, March 7 as saying, and I quote "We cannot reach our objective without the cooperation of the Americans. For the moment we are going it alone but we need them badly". Well, I submit to you today that unless we bring our NO_x standard in line, we will have great difficulty requesting and receiving the necessary cooperation from the U.S. that Mr. Brandt refers to. I find it tragic to think that potentially significant inroads in the North American acid rain problem could be lost because we, in Canada, failed to come to grips with our NO_x emissions.

The second issue we at the Movement would like to raise concerns the deadline attached to last week's announcement. A 50% reduction in SO_2 emissions is significant, but a 10-year period in which this reduction is to be achieved is a long time. The Movement Against Acid Rain questions whether Canada can afford to wait 10 years before our emissions are brought under control. We cannot allow our lands and waters to become further degraded. And we have only to look at Sweden and Germany to see the extent of the damage that lies ahead if we do not move quickly, and, if necessary, forcefully. Legislation requiring the 50% reduction should be tabled to ensure that emissions are reduced by realistic amounts within reasonable time frames. This ensures that compliance with the reduction order occurs on a steady, manageable, quantifiable basis. One major advantage of the process of staged reductions is that it increases the saleability of the Canadian initiative to the U.S. by providing easily measured reductions in emissions on a regular basis.

As Mr. Brandt pointed out, we cannot succeed in bringing acid rain under control without cooperation from the United States. For this reason, the recently announced Canadian initiative must not only work, it must also be seen to be working. The U.S. must see that we are serious about our own initiative and that it is being enforced. Above all else, we must sell our initiative to the United States.

John Lawson
Tourism Industry Association of Canada, Ottawa, Ont. K1P 5G4.

I recently attended a conference in Charlottetown, P.E.I., on Tourism, and this was a larger conference than they are used to having in Charlottetown. The airport is not particularly large, but anyway they had to put on an extra-large airplane out of Toronto to transport all of our delegates. I was on that plane sitting in the front row when they happened to have the cabin door opened. I could overhear the discussions between the pilots; it was rather bad weather, being a February conference and as we were coming down, I determined that neither the pilot nor the co-pilot had ever flown into Charlottetown before. They don't have quite as sophisticated gear for bringing planes down as they do in Toronto, Vancouver and other places they were used to flying, and as they were coming down through the fog and snow and so on, the pilot was commenting to the co-pilot that he was having some difficulty; they were peering out through the window trying to see, a visual landing. Anyway, they finally got that plane down and they put wheels on the runway and all of a sudden brakes went on, they screeched to a halt sliding off the runway, off against the perimeter fence. The pilot says to the co-pilot, "Boy, they have short runways down here." The co-pilot looks out the window to the left, then he looks out to the right, and says "Yeah, but are they ever wide." The point of the story simply is that there is a variety of perspectives on any problem. In the case of the pilot, it was a problem of bringing an airplane down on the ground. In our case, it is the problem of solving the acid rain problem, and the various speakers here obviously have various perspectives on that problem, although I am finding that there is a great deal of similarity. I think you are going to become awfully bored with my comments as my statement will be very similar to those who have gone before me, and I suspect those who are coming behind me.

For those of you who may not be familar with the Tourism Industry Association of Canada, we are members of the Canadian Coalition on Acid Rain. TIAC is the national, private sector association representing the interests of some 100 000 businesses involved in the tourism industry. Our membership includes both large and small companies deriving all or some of their revenue from transportation, accomodation, food and beverage services, events, attractions, as well as many related services, including banking and retail sales. We are concerned with the welfare of the largest airlines and hotel chains right down to the smallest resorts and fishing camps. The following statistics, which are provided by the Federal Government (Statistics Canada), will give you an idea of what these businesses mean to Canada. Tourism in Canada is an $18-billion industry representing 5% of our gross national product. It provides 1.3 million jobs, 11% of Canada's working labour force. Tourism is an export industry with major foreign exchange implications for this country. In 1983, for example, we experienced a $2.1 billion balance of payments deficit on the travel account, according to Statistics Canada. That's up, by the way, from 10 years ago when we had a $300 million dollar deficit. In 1982 we had a $1.3 billion deficit, in 1983 we had a $2.1 billion deficit. Those are not funny figures.

Of perhaps more relevance to this conference, sport fishing alone generates well over $1 billion of direct and related expenditures across Canada. In Ontario, there are some 50 000 people employed in the fishing, hunting lodge, and camps sectors. Since our natural environment is the greatest tourist attraction Canada has to offer, you will understand that we in the tourism industry are very concerned with its careful management and preservation. The cumulative and devastating impact of acid rain on this environment is well documented. We know, for example, that over 50 million tons of sulphur and nitrogen oxides were released over North America in 1980 alone. Thousands of lakes and streams have as a result been acidified to the point where fish can no longer live and we are told tens of thousands more are threatened. In Ontario, over 1400 lakes and ponds have been lost and the Ontario government tells us that 48 000 more are seriously

threatened. Put these effects together with those now being detected in forests and farm production, and on drinking water supplies, and we recognize a problem that requires immediate and strong corrective action.

These problems as they relate to tourism, their causes, and their solutions are discussed at some length in a paper prepared last March in cooperation with the Allied Boating Association of Canada, Canadian Coalition on Acid Rain, Ontario Federation of Anglers and Hunters, Northern Ontario Tourist Outfitters Association, Resorts Ontario, and Tourism Ontario (a copy of this report titled *The Position of the Canadian Tourism Industry and The Canadian Coalition on Acid Rain on Acid Rain Control* is appended to these proceedings).

I won't dwell on the causes, as I am sure you are all well aware of these. As for solutions, our position paper calls for Canada and the United States to each reduce their emissions of sulphur and nitrogen oxides by 50% by the end of this decade. The majority of these reductions must be achieved through limitations on sulphur dioxide emissions from power plants and non-ferrous metal smelters. The paper also calls for tightening of the Canadian nitrogen oxide emissions standard for light-duty vehicles from 3.1 grams to 1 gram per mile in order to conform with the United States federal nitrogen oxide emission standards. We asked for reductions from all major Canadian sources, most particularly the Inco smelter in Sudbury, Ontario Hydro coal-fired power plants, and the Noranda Mines smelter in Rouyn, Quebec. We also call upon the American Congress to enact legislation that will reduce sulphur dioxide emissions in the thirty-one eastern states by 50% by 1990.

TIAC and its allied groups believe that acid rain at present levels is seriously damaging the quality of life in this country and in the United States. We also are strongly convinced Canadian and American citizens are prepared to pay to maintain their quality of life and to assure that a safe and healthy recreational environment is left as a heritage to our children. In addition, there is no question in our minds that Canada's economic infrastructure cannot afford to sustain serious damage to the tourism and recreation sector. If you don't think that acid rain will seriously affect tourism, I can assure you that it would only take a couple of headlines in the U.S. and European media to the effect that Canadian lakes and rivers are dying to scare many thousands of tourists away. This would surely lead to lost foreign exchange and more lost jobs.

We have been somewhat encouraged by the news last week of Canada's decision to proceed independently of the U.S. in setting a 50% reduction in sulphur and nitrogen oxide emissions. This step will permit us to make a much stronger case in the U.S. for similar reductions. As I said, we were only somewhat encouraged. We are not pleased that this reduction is to take effect over 10 years or that it is to be a reduction from the 1980 allowable emissions rather than the actual emissions. In case you weren't aware, there is a 700 000-ton difference there. I understand that Senator George Mitchel from Maine is on "Canada AM" this week, and that he is expressing concern over this particular issue.

The experts have been saying that we can't afford to go slow. They and we have been calling for a 50% reduction by 1990, not 1994, and this is suggesting that we can only do it in ten years. I suggest that we can find ways if we really want to get something done. Coming out of the private sector, I know that when you have to do a job, you do it, and I think we can do it in less than 10 years.

Also, the proof will be in the pudding. The announcement by the federal and provincial environment ministers provided no indication of the means to achieve the goal or the sources of funds to pay for it. The cost to industries involved in the acid rain clean-up will be substantial. A recent Ontario federal report, for example, noted that the most stringent clean-up of the Inco Ltd. smelter in Sudbury would cost in excess of half a billion dollars. This was confirmed in today's Citizen by Ontario Environment Minister, Andy Brandt, who suggested that the total cost in Canada could exceed one billion dollars, and I suspect that is even conservative. We therefore urge the Canadian federal and provincial governments to provide assistance to companies involved in the acid rain clean-up by means of tax incentives, loans and loan guarantees and other similar forms of financial assistance that may be available, in order that this most serious environmental and economic problem can be solved at the earliest possible opportunity. We, for our part, will do all that we can to encourage tourism interests and governments on both sides of the border to enact stringent emission control programs as soon as possible. I wish to mention one other concern that we in the tourism industry share with many other interest groups. We hear that the Minister of Fisheries and Oceans is considering a possible reduction or elimination of the acid rain research budget for his department. This budget is used to generate some of the best data available for monitoring the impact of acid rain in Canadian lakes and rivers. We would consider a decision of this nature to be a very negative one, and we in the tourism industry urge the Minister not to tamper with a good use of his Department's resources.

Roger Liddle

Northern Ontario Tourist Outfitters Association, North Bay, Ont. P1B 8K4

The Northern Ontario Tourist Outfitters Association, known as NOTO, represents the fishing and hunting lodge industry in northern and northwestern Ontario. NOTO was founded in 1928, some 56 years ago, and currently has a membership in excess of 1000. Our members, for the most part, offer accommodation and boat and motor rental services and facilities to the vacationing sport fishermen travelling within northern Ontario. Our members are all small businesses operating in both the popular vacation areas and the remote hinterlands of the north. We are totally, and I repeat totally, dependent upon a healthy sport fishery resource. In essence we sell the opportunity to go fishing. That is why we are so very concerned. We see our businesses, our livelihood, our hard-earned assets and our employment of thousands of Canadians across the north sitting in a very precarious position.

NOTO and our members have been very concerned about the effects of acid rain for many years now. Back in the mid-1970's, when it seemed that Dr. Harvey from the University of Toronto was the only person concerned about acid rain, our members were greatly concerned. You see, we were already feeling the effects of acid rain. The lakes that so many of our members depended upon were dead or dying.

We took the issue so seriously as an industry and as an association that we joined forces with the Canadian Coalition on Acid Rain and have continued to support that group both with time and financial resources. In 1980, we as an association, for example, donated to the Coalition $25,000, which depleted our financial resources to fight this deadly issue. We were concerned. We still are. Since then, our members have continued to make substantial financial contributions to this and other interest groups fighting acid rain. One member, just last month, wrote me that he views the acid rain issue in our north as seriously as those in the south view rape and drugs. It is a crime against humanity, he wrote, and it's not only our sector of the tourism industry that is concerned. In addition to the total of the Ontario Tourism Industry there are 49 other such member groups in the Coalition who view the issue with equal seriousness.

As a concerned representative group with a specific interest in the subject of acid rain and the many research areas associated with the issue, we feel it appropriate to say how shocked and concerned our members were when learning through the media this past January that acid rain research could be halted. It is our understanding that two major acid rain research programs in Canada could end this year if financing is cut off by a federal Cabinet Committee. We very strongly believe that Canada must continue efforts to monitor the sources and biological and ecological impacts of both nitrous and sulphurous oxide emissions. The Government of Canada cannot afford to be perceived to be any less committed to furthering acid rain studies and emission controls technology than our neighbours to the south. To do so would seriously blacken an eye for Canada, not only scientifically but in the context of recent criticisms by U.S. officials of Canada's pursuit of acid rain control measures. We urge the federal government to ensure that our national commitment of financial and human resources to research, monitor, and control sources and impacts of air pollutants that cause acid rain be substantially increased in 1984.

As an industry, we feel it vital to point out the tremendous economic impact our sports fishery has on the province of Ontario. In the fishing lodge industry in Northern Ontario, there are 1600 licenced tourist establishments dependent upon the sports fishery. Those 1600 establishments alone employ over 15 000 full and part-time employees. Thousands more are employed in support sectors of the industry. But the economic significance of the sport fishery does not depend solely on the lodge industry. According to a 1980 survey, over 2.8 million Ontario residents and non-residents spent close to 38 million days fishing in Ontario. Direct expenditures amounted to over $508 million. From these figures, a number of obvious conclusions can be made. Sport fishing is a major recreational pastime of residents. It is a major drawing card for non-residents, primarily Americans, and it contributes significantly to the economy of the province and the country. In addition, Ontario's $6.5 billion tourism industry is dependent upon our ability to offer the vacationing public a well-rounded portfolio of destinations and activities. Acid rain has already affected our tourism industry: our recreational pursuits, our forests, our land, our buildings, our fishery and our livelihood. The NOTO Association strongly urges our federal government to continue serious efforts to monitor the numerous sources of acid rain falling within our country, to study both the biological and ecological impacts of acid emissions, and of reducing the harmful effects already felt. In short, there should be no area left unexplored, no viable method untried, and no commitment of financial and human resources spared.

Specifically with regard to the Department of Fisheries and Oceans, we see a need to concentrate on the socio-economic loss evaluation associated with the fishing lodge industry in Ontario, as well as the loss to fish populations in those areas utilized by our industry and the resident sport fishermen. We also see a vital need to continue the collection of primary data and the furtherance of testing in those areas with heavy sport and commercial fishing. We do not define any geographical boundaries for these evaluations. The issue of acid rain is a Canadian issue. It affects the constituents of North Bay, Ontario and of Halifax, Nova Scotia alike. The simple truth is that time is running out and we had best get on with the job.

Magali Marc

La Société pour Vaincre la Pollution, Montreal, Que. H2Y 3E9

La Société pour Vaincre la Pollution is a Montreal-based non-profit citizens group. We can trace our interests in the effects of acid rain on our environment as far back as 1979, when no studies on the Quebec environment had been done. Our task was to bring public attention in the province of Quebec to a problem that was only known to the scientific community.

It was not until 1981 that we were able to gather enough funds to launch a major information campaign throughout the province of Quebec. With a subsidy from Environment Canada, we were able to train a team of eight people and to visit ten regions in the province of Quebec. We spoke to the farmers, to the naturalists, to workers' unions, we spoke to forestry associations, to outfitters associations, to administrators, to students and to people who were involved in health professions. However, at that time we had little information to go on. Our guess that acid rain had deleterious effects on Quebec's lakes, rivers and forests was mere deduction, but based on sound knowledge of the sensitivity of Quebec soils to acid rain in most of the province. Although our lecture on what acid rain was all about (we had to start from scratch) came as a shock to our various audiences, the fact that we had little data on the state of our environment made it difficult to convey a clear picture of what the future had in store for us.

In giving lectures about acid rain, in giving press conferences, in writing memoires, position papers or acid rain kits, we always aimed at increasing public attention and public pressure on governments and pollutors. We had realized that if a solution to acid rain was to be reached, it would be reached through the strength of public concern. We thought that politicians would aim at solving the acid rain problem because they want to get re-elected and that scientists would do the right kind of research on acid rain because they need to obtain subsidies from politicians who want to get re-elected. Well, this line of reasoning proved to be rather simplistic. As I peer through a list of studies being conducted or planned in Canada and in the United States on the subject of acid precipitation, I find titles such as "Growth Changes of Apple Seedlings in Response to Simulated Acid Rain." Now Mr. Reagan is saying that more research is needed and puts

$55 million in research. While Canadians begin counting dead lakes, some scientists are working in their sophisticated laboratories to show how simulated acid rain can affect the growth of apple seedlings.

Citizen groups such as La Société pour Vaincre la Pollution devoted to the protection of the environment are witnessing year after year the endless squabbles between Canadian and American officials over who will begin first to reduce at the source the emission of acid rain precursors. Lately, the Canadian provinces have further procrastinated on a solution to acid rain by choosing 1994 as a deadline for the over-all Canadian effort to reduce SO_2 emissions. Why should the Canadians hurry, they argue, when most of the acid rain problem remains unsolved because the Americans are not doing their share? Why spend millions on emission reductions, argue the Americans, when the Canadians themselves are showing so little haste in cleaning up their own backyard? While you and I know that the problem of acid rain requires urgent solutions, everybody is dragging his feet.

This is why, although I am not a scientist, I feel that how simulated acid rain effects apple seedling growth is a somewhat irrelevant question. Maybe I have chosen an extreme example for illustration, but the same idea applies to the studies which are being conducted in laboratories. La Société pour Vaincre la Pollution urges scientists to get out of the laboratories and to go and study the real world. This way, they can tell us what is going on now in our environment.

In that respect we are ever thankful that scientists at Fisheries and Oceans went to the Rivière des Escoumins to measure the impacts of acid spring shock on the Atlantic salmon. Not only is the survival of Atlantic salmon of utmost importance for the Quebec economy, generating annually several million dollars in revenue, but the region "La Côte Nord" (the north shore of Quebec), where the river is located, is one of the regions in Quebec which is particularly plagued with unemployment and poverty. To study the effects of acidic precipitation on the Rivière des Escoumins in the north shore of Quebec is therefore to bring scientific research together with socio-economic interests. Moreover, to provide the public with dependable data on what is actually happening in our environment is invaluable for citizens' groups and for Canadian officials who can no longer be accused of inventing the problem of acid rain for the sake of making American energy less competitive with Canadian exports of electricity. We are not unduly mistaken as to the attitude prevailing behind such accusations. They are made in bad faith. However, these are the kinds of arguments with which we are confronted and which we have to answer.

This brings me to the conclusion that, while we are facing the Reagan administration's stubborn denial of the urgency of the acid rain problem, our only hope is that scientists will come up with information on what is happening now in terms of acidification of our environment and what projections can be made for the future in relation to what we already know. I think I have sufficiently emphasized that what we need is field research, not laboratory research. This is what Fisheries and Oceans has been doing. Not only do we commend you for your intelligent work, we support your efforts by protesting the budget cuts that were announced. Despite the fact that we have been saying that action is needed to reduce acid rain, and that enough research has been made, we are not afraid to be contradicting ourselves now simply because we are fully aware of the implications of not having further arguments to convince Americans of how serious we are about acid rain. We realize only too well that the situation between Canada and the United States with regards to a solution to acid rain is stalled and that we need your work to help us get out of the trench.

Alan Penn
Cree Regional Authority, Montréal, Québec H3B 3N9

Introductory remarks

The following brief is being presented on behalf of the Grand Council of the Crees (of Québec) and the Cree Regional Authority. These two organizations together provide a range of support services to the eight Cree communities of Northwestern Québec. Among these services is professional advice in connection with the environmental and socio-economic impact assessment of development affecting the James Bay territory and the populations, native and non-native, living there. It is in the context of these technical support services that the present brief is submitted for the James Bay Crees.

I am a consultant to the Crees who has been active in the area of environmental impact assessment in the James Bay region of Northwestern Québec since the early 1970's. My involvement dates back to early attempts to assess environmental impacts (including water quality changes) associated with the La Grande hydroelectric project and other, related hydroelectric developments planned for the territory. My particular interest in the subject matter of this seminar derives from my current work on the planning of future ecological impact monitoring programmes for the territory, and a conviction that an unusually complete data base on native use of freshwater fisheries resources provides an unexpected opportunity for evaluating models for the assessment of long-range impacts of acid rain on native fisheries. I have also been involved extensively in research aimed at documenting and understanding the phenomenon of methyl mercury accumulation in freshwater fish in this region — a subject of relevance to this seminar because of the link between acidification and increased rates of mercury bio-accumulation.

My presentation is divided into two major sections. The first deals primarily with the James Bay Crees and what I understand to be their perspective on the problem of acid precipitation. The second section is more personal in approach, and attempts to offer to the seminar some comments and recommendations on the application of impact assessment methodology to the assessment of the regional impacts of acid precipitation.

a) The James Bay Crees and their perspective of the problem of "acid rain"

The James Bay Crees number approximately 8500 and occupy about 300 000 km^2 in the James Bay and southern Hudson Bay watersheds. Their economies are based on eight permanent communities of recent date (1950's and 1960's as residential settlements as opposed to trading posts): five are located on the coast, and three inland. Many of the Crees are still active subsistence hunters and trappers. Although generalization can be misleading, roughly half of the 2000 or so Cree family units (about 25% of Québec's Indian population)

devote the greater part of their time, and derive most of their income, from subsistence harvesting-related activities. Active hunters practice a form of transhumance, and in fact are resident in their home settlements for only about three months of the year. Commonly, part of spring, summer and fall months are spent at fishing camps. There is extensive food-sharing, so that a great majority of Crees share in the subsistence harvest.

As communities of fishermen, the Cree as a whole find themselves at the top of an aquatic food chain. As a result, some of the communities are among the groups most exposed to methyl mercury, in Canada and even worldwide. This is a straightforward and direct consequence of the unusually high concentration factors associated with freshwater fish ecology in the generally strongly oligotrophic aquatic environment of the James Bay watershed.

Exposure levels to methyl mercury have been high enough to justify neurological research on an epidemiological scale to assess their potential impacts on the health of the Crees. Much of this research was carried out between 1976 and 1979, during the period when, as a result of work in Scandinavia and Ontario in particular, it became clear that acidification of freshwaters was accompanied by a sharp rise in methyl mercury levels. As the Crees have been obliged at various times to reduce considerably their consumption of freshwater fish (in 1975 and 1976 there was an attempt to close the regional subsistence fishery completely), they have a direct interest in large-scale changes in water quality which affect mercury levels in fish. Acid deposition, alongside hydroelectric development and large-scale forest harvesting, all tend to bring about an upward trend regionally in these mercury levels.

These concerns have to be seen in the light of the recent monitoring of mercury levels in fish associated with the impoundments of the newly built La Grande hydroelectric Complex. The reservoirs and forebays of this Complex have a total area of nearly 11 500 km^2. The soils flooded by this project are gradually being transformed underwater. What seems to be happening is that soil organic matter is being oxidized, and the associated trace metals, including mercury, are being released into the water column. This has resulted in three-to-five fold increases in mercury concentrations in the fish species used by the Crees, and a consequent increase in human exposure levels. Other hydroelectric basin development schemes, to the north (Complexe Grande Baleine) and the south (Complexe Nottaway–Broadback–Rupert) are being planned. It has become very clear that methyl mercury bio-accumulation must now be considered a primary ecological concern arising from hydroelectric development. Naturally, the question also arises: to what extent does acid precipitation in the James Bay region accelerate this phenomenon of rising mercury levels in the fish in the new reservoirs.

The Cree subsistence harvest of fish is unusually well documented as a result of a 5-year co-operative study by the native and government signatories to the James Bay Agreement. This study was designed to evaluate current levels of use of subsistence resources as a basis for future resource allocation between subsistence and non-subsistence uses. Roughly speaking, the Cree subsistence harvest is approaching a million kg of edible meat each year, of which about 15%, or 150 000 kg, is fish (a figure undoubtedly affected by policies aimed at reducing fish consumption because of mercury levels). The fish catch in some communities provides 25–33% of the available protein from bush food, and, on a regional scale, the high-mercury predatory species (mainly pike, walleye and lake trout) account for about 40% of the catch. It has generally been assumed (depending, of course, on the public health implications of mercury concentrations) that the overall level of fishing is on the increase, and will represent a large fraction of the total harvest in future years.

The Cree are involved in a number of outfitting operations for sports fishermen and, at the time of writing, own and operate at least five outfitting camps in the territory. The people involved share, with other outfitters, the general concern that acid precipitation will have a long-run negative impact on their outfitting operations, and that the associated problem of high mercury concentrations will continue to discourage visitors in the future. This is partly a consequence of mercury (on the grounds of which several commercial operations were terminated in the early 1970's), and partly a consequence of the low productivity of the northern aquatic environment and the vulnerability of fish stocks. However, groups from several Cree communities are actively involved in the feasibility studies necessary to initiate new commercial operations in the territory, and the economic interest is quite apparent.

The environmental impacts of forestry operations, particularly the large-scale and highly mechanized operations which have been the rule since approximately 1977, are also of direct concern to the Crees, who see the organization of their hunting and fishing activities radically affected from year to year in the southern part of the territory by these commercial forestry operations. Both terrestrial and aquatic impacts are involved. Acid precipitation is arguably affecting the nitrogen and sulphur budgets of northern forest soils, and the flux of these and other nutrients, as well as trace metals, into adjacent watercourses. The Cree, like other interest groups, have also posed the question: how is acid precipitation going to affect the productivity of the northern forest environment in the future, and how, in turn, will this affect the availability of the animals they use? Of course, these are questions which are intrinsically difficult to answer, but they are nevertheless legitimate.

I hope that these brief explanatory remarks will serve to illustrate some of the reasons why the Cree consider themselves as having cause to be concerned by the phenomenon of acid precipitation. Some of their concerns are clearly grounded, while others are more difficult to assess. In any case, it is difficult to evaluate the long term potential impacts for the Crees, but the Cree join with other groups in maintaining that the necessary research needs to be carried out.

b) Some thoughts about the evaluation of the environmental and socio-economic impacts of regional acid precipitation

I turn now to what may be considered a more controversial aspect of this presentation. My primary concern here is to draw attention to what appears — in the regional context of the James Bay territory at least — to be important oversimplifications in current views of the impacts of acid precipitation, and their assessment in both environmental and socio-economic terms. Although in this forum, it is only possible to sketch the bare outlines of this issue, I chose to present these concerns because they naturally arose in the course my own attempts to answer the question: do the Crees

have good reason to be concerned about the environmental impacts of acid precipitation in the territory they use?

Northwestern Québec, on maps recently prepared by the Federal government to describe regional sensitivity to the impacts of acid precipitation, does not appear to be a primary area of concern. I readily acknowledge that, within Québec, the hills north of Québec City certainly offer an environment which is much more immediately threatened by acid precipitation. Much of the James Bay territory, however, lies in a zone where mean annual precipitation pH is of the order of pH 4.5 to 5.0 (on recently published maps), and where an important segment of the geological units of the territory (the flat-lying muskegs, clays and other lacustrine deposits of the central James Bay lowlands) are designated as of moderate or low sensitivity. Is this a fair assessment?

In the first place, I think it is fair to point out that the region is not well covered at the present time by precipitation sampling stations integrated into the national networks. For example, southern James Bay lies downwind (at least in winter) of Noranda, one of the two largest point sources of SO_2 emissions in Canada; but the coverage does not make it possible to trace the zone of influence of this important stack. Secondly, the geological evidence for considering the central James Bay lowlands as of moderate or low sensitivity is quite slim. It is, in fact, already a highly acidic environment. The chemical properties of surface waters are very strongly influenced by the drainage from widespread and markedly acidic muskeg and peat, and the major rivers have dissolved organic matter concentrations often of the order of 10 to 30 mg/L. Major drainage systems are characterized by large, shallow lakes in which wind-driven circulation results in pale brown turbidity readily recognizable from the air.

The chemistry of the major rivers is inevitably influenced by the drainage from the extensive muskegs and peats, and by processes occurring within the major lakes of central James Bay. Against this regional background, what is the significance of acid precipitation? The environment is already acidic, and (unless we descend into the aluminium and iron controlled range), the buffering capacity of surface waters is limited. With the important exception of dolomite-containing formations in eastern James Bay, carbonate minerals are rare or absent. The environment is acidic, but to what extent is it vulnerable to further acidification?

These questions provide an opportunity to make the much more general remark that the assessment of impacts on aquatic environments has been heavily targeted at the obviously sensitive headwater lake environments with small catchments, limited groundwater flow, and rapid response time. This emphasis has, as a necessary consequence, the result that it becomes much more difficult to make intelligent statements about regional impacts on the scale of intermediate and large drainage basins. At these scales, soil-forming processes, and the geochemical characteristics of surficial deposists, begin to exert important controls on surface water quality in their own right. Canadian research has tended to bypass the problem of evaluating impacts on the scale of the drainage basin, and in the light of soil-forming processes. One consequence of this, I feel, is that large territories of boreal Canada — of which James Bay is an example — fall in an immense "grey zone" where we really have very limited knowledge of present and future impacts of atmospheric water chemistry on surface water quality. It will be necessary, in the future, to deal with the important exchangeable acidity associated with boreal forest soils and the role of muskeg forming processes and drainage from them. This is not to understate the importance, for example, of the strongly acidic run-off from the melting winter snowpack, but rather to stress the complementarity of different research strategies.

A similar problem can be identified in debate about the relative importance of nitric and sulfuric acids in acidification in the environment in general and in James Bay in particular. The biological transformation of nitrate, and its assimilation as protein, not only neutralises the nitric acid, but actively consumes hydrogen ions; it is a buffering mechanism in its own right. Moreover, there is reasonable evidence to suspect that the boreal forest tends to be nitrogen poor (and perhaps even sulfur poor). Deposition of nitric and sulfuric acids may therefore have a beneficial effect on the nutrient status of forest soils, but this effect may be masked by other problems associated with the mobilisation or leaching of metals within the soil, including aluminium, which has been implicated in environmental damage to softwood forests in central Germany. Are the respective roles of nitrate and sulfate to be considered in evaluating impacts in the northern environment, and the strategies of emission abatement? If so, in what terms? These have certainly not been primary considerations so far, but have immediate relevance in a discussion of the relevance of acid precipitation in James Bay, for example. Strategies for dealing with nitric and sulfuric acids are necessarily linked, in so far as the evaluation of remedial strategies are concerned.

Liming, as a remedial strategy, has generally been viewed with displeasure in Canada, although it is an integral feature of the response of governments to impacts of acid precipitation in Scandinavia. Remedial liming continues to receive relatively little attention, and it seems to have become widely taken for granted that such intervention has little economic justification. For the kinds of reasons I have stated above, I consider that the case has not been demonstrated adequately. There are several instances where liming may have tangible, although local, benefits. Increasing attention is being given elsewhere to forest fertilization and liming as a remedial strategy, and to the control of the pH at spawning sites deemed critical for certain fish species. In view of the widespread concerns in this country about forest regeneration, and the loss of fish stocks because of acid-related stress at spawning sites, it seems that these subjects merit more concern here. More specifically, they should be considered explicity in the ongoing discussion about the development of appropriate economic and social impact assessment, and in the application of techniques of cost–benefit analysis to the review of remedial strategies.

The brings me to my final observation today. This seminar is succeeding in demonstrating the importance of refining cost/benefit evaluation and economic impact assessment in the context of acid precipitation. This is an interesting and refreshing initiative. Because of the particular social and political context of the James Bay and Northern Quebec Agreement, the James Bay region potentially could serve as a useful case-study for developing and evaluating alternative cost/benefit and impact assessment models with native, subsistence economies in mind. Important data bases already exist which can be adapted for the purposes of economic impact assessment modelling, and the Grand Council of the Crees, with the Cree Regional Authority, are willing to collaborate in the development of appropriate assessment meth-

odology. We look forward in the future to productive co-operation with the Department of Fisheries and Oceans in this area of economic impact assessment of acid precipitation.

Alan Roy
Union of Ontario Indians, Toronto, Ont. M5C 2M6

The Union of Ontario Indians is also a member of The Canadian Coalition on Acid Rain. In putting this presentation together, I tried to think of some specific objectives for this particular seminar. My understanding was that there would be some briefing papers or guidelines for future research, essentially to help the Canadian Foreign Affairs Department in their negotiations with the American government to bring about some change in this acid rain situation. I thought that I might try to bring forward some information that Fisheries might not be aware of and suggest some areas that need further research from the economic standpoint. The Union of Ontario Indians has an environment program which services about 40 Ojibway communities in Ontario, essentially around the Great Lakes.They have a population of about 30 000 people; most of the communities fish in the Great Lakes and in many cases they also have their own small lakes on their reserves or they use lakes in the northern shield area. So a lot of the lakes are in a granite non-buffered type of situation. Their treaties give them the right to hunt and fish according to their domestic and some commercial needs and not according to quotas, species limitations, seasonal or equipment usage restrictions.

Some of the general statistics on the fishing activities will illustrate how essential that source of food is to dietary, economic and cultural considerations in their lifestyles. There were some specific questionnaires conducted on reserves by Indian people and these have given us some insight into these particular statistics. They were done last summer and were quite extensive because we had to get a handle on the economic priorities of the communities that are represented in central Ontario. The reason this all came to a head was the Ontario Government and the Federal Government wanted to formalize economic priorities in relation to the fishery, and specifically the native fishery in Ontario. I guess one point that's important to consider here is that the people live in the 40 communities (that I'm talking about) permanently, and many of them work either harvesting timber or trapping in the winter, and maybe fishing in the summer. They carry on a lifestyle and an employment pattern that involves harvesting, and there are quite a few families involved in this particular activity in central Ontario. So we found in the survey that 50% of all Indian people in those communities have fished at some point in their lives for some substantial period of time. Over 60% of the food obtained is obtained from grocery stores, but 15% is derived from fishing and another 15% is derived from hunting. That figure for protein from fishing was quite a bit higher even as early as a decade ago. About 40% of the Indian households buy fish, on an average of 40 lb per household per year for the communities in central Ontario. So they are not only fishing for themselves. When they don't get enough from their own activities, they are buying it.

There is a variety of species totalling 1 million lb. About 60% of them are eaten by the fishermen's family and 40% were available to other band members. The species involved were pike, whitefish, bass, walleye, trout, perch, and smelt and they were used in that priority of preference for personal consumption. To assess the impact of acid rain on native fishing, statistics are vital for different geographic areas because acid rain has a different effect if you look at southern Ontario, central Ontario and northern Ontario. So we looked at the commercial licenses that were granted for the different areas. Indian people had 151 licenses, which represent 14% of the total 1054 commercial licenses in Ontario. And based on a 5-year average, from 1977 to 1981, Indian fishermen produced 3% of Ontario's annual 57 million pound harvest and received about 4% of the cash, that's $.8 million on a reported $21 million return for the industry. Of the 151 licences used for Indian people, either band licences or family licenses within the province, 84 of the licenses are in the northern zone. Fifty-one are the north central zone and 16 are in the Great Lakes.

Now, those statistics are significant in that the native fishery in the Great Lakes is only 2% of the total. Therefore, we have two reasons not to be too concerned about the Great Lakes fishery: there is not a lot of native Indian activity on it and acid rain doesn't have as much of an effect on the Great Lakes. It does, however, have a tremendous effect in the northern zone, and there the native licenses comprise or are involved in 90% of the fishery. The most sensitive areas for acid rain are mainly in north-western and northern Ontario. Most of the licenses that are involved in the Union of Ontario Indians area are in the central zone and there are a few in the northern zone. Most of the Indian commercial licenses are in the areas that don't have buffered lakes. These northern and central zones have strong economic competition *from* fish marketing operations on Lake Michigan. The decline in trout, walleye, pike, perch and bass is evident in these northern areas and can represent an increase in marketing for the Michigan areas from the point of view of competition. The substantial income for Indian people could be threatened by a loss of this fishery; even a decrease in the quality of the fishery in this area could seriously jeopardize their competitive status. Based on a 5-year average from 1977 to 1981, that fishery produced 57 million lb of fish with a landed value of $21 million, which worked out to about 38 cents a pound. The native fishery share of this fishery for the same period was 1.5 million lb and corresponded to $0.8 million. Again to illustrate the performance in the different areas, the native performance in the northern inland fishery represents 1.4 million lb of landings with a corresponding value of $0.8 million. Approximately 75% of these landings and values are generated in the northern inaccessible areas.

Most Ojibway communities within the Union of Ontario Indians have small lakes or rivers on their federal land that produce catches for domestic consumption. Many of these lakes have witnessed declines in fish populations during the last decade, especially walleye, bass and trout. This decline happened in spite of low fishing pressure on these lakes. In some cases there was small band membership (or population) and there wasn't any strong pressure on the lakes at any given time. In some other cases where membership was high, some of the bands have passed band council resolutions restricting fishing. The point I'm trying to make here is that on many of the lakes in which we have noticed the declines, there has been very little fishing pressure, and because they have been on Federal land we have been able to control exactly who

fishes on them. Yet we have seen a decrease in fishing, and we suspect that acid rain has some implication here. We haven't been able to do any research on these lakes but we are trying to get some funds to do that specifically.

During the mercury pollution situation in the 1970s, one research project by the regional office of Indian Affairs in Ontario was to locate all lakes in central Ontario that Indian people use as a source of fish for their diet. These lakes were to be correlated with known lakes with degrees of mercury contamination and subsequent warnings were to be issued to Indian communities. This research resulted in two significant facts for this particular presentation. It was noticed that Indian people rely on a large number of small lakes for domestic supplies of fish, they eat enormous quantities of fish at any given meal, and they eat fish often, several times a week at certain seasons of the year. It is important to consider these lakes and that source of protein; if they weren't available and there weren't any financial or other resources to replace the fish, Indian people would be at a disadvantage in their diet.

Fishing is also a very important family community activity throughout certain seasons. When this particular activity declines there is stress put on the family structure, the community structure. We have noticed in places like Grassy Narrows and White Dog, where fishing had to be curtailed, it really resulted in severe stress on the community, not only from an economic point of view but from a social point of view. We've noticed too that the people in the Union of Ontario Indians have a couple of treaties that are very, very strong on the statement of fishing. The Robinson–Huron Treaty, which essentially is a tract of land on the north shore of Georgian Bay, is probably one of the strongest treaties of Canada. It determines the right of Indian people to fish in compensation for the amount of land they gave up. And if that particular opportunity to fish is jeopardised by acid rain or any other environmental factor, Indian people will feel it very strongly. There will be a feeling of being cheated, of being deprived of a certain right.

In northwestern Ontario and northwestern Quebec, where lakes and rivers had been closed to fishing because of mercury pollution, Indian people have substituted substantial quantities of carbohydrate for that loss of fish. Some of the items that show up are macaroni, white bread, that kind of thing. In those specific areas Indian communities have experienced a decline in general health. Leading the list of diseases are conditions of obesity and diabetes, and diet is involved in both of those conditions. One of the suggestions that I've thought of for the communities in central Ontario is: we have a pretty good handle on the amounts of money that are spent on health care for native people; we know that the diseases that I've just mentioned head the list, up to over 50% incidence in many communities; and we know that those diets and eating patterns have changed drastically in the last 20 years, a shift towards a carbohydrate type of diet. I'm suggesting that although it would be difficult to put an impact on this, maybe there's some ball park figure of amounts of money that the Federal Government is spending in relation to these diseases because of the shift in diet. And if fish declines in the area in the future, there will be a very severe shift in the diet and I think there will be a drastic change in the health status of people in this particular area. Even if you looked at it from a remedial point of view, Health and Welfare would have to spend a lot of money from the point of view of health education or anything else to try to shift this diet back to one that wouldn't be contributing to diabetes or obesity or some of the other conditions that go with poor diet.

Another point that I would like to raise for some more research might be the heavy metal contamination that goes along with the increase in acidification of the lakes, and in some cases, rivers. One of the rivers that caught our eye in central Ontario was Serpent River, which comes down from the Elliot Lake mining complex. Now, Elliot Lake doesn't put their mine tailings in the lake or a river, they put them near the river and the wind blows small amounts of the tailings into the water. That rate of mine tailings getting into the river hasn't changed a great deal over the last ten years, but the concentrations of heavy metals in the water have gone up substantially in the last five years. We think it may be related to the pH level, but we don't know yet; again, it's another piece of research that hasn't been done.

Another thing that I'm conscious of is that much of the drinking water comes from a surface water source for the 40 communities that I'm involved in, and some of these water sources are in a very heavily mineralized area of central Ontario; I think it is something that if it isn't a problem now, could be a problem in the future, and I think this is again something that should be brought to the attention of the Americans. There is a whole host of things here that could add up to a health hazard but it's not proven yet, we don't have any data to back it up.

One other point that we have noticed is the effects on forests on some of the reserves in central Ontario. We have two communities with extensive sugar maple hardwood plantations and they have experienced serious die-back disease in the last few years. Again, we are in the process right now of doing some research into determining the cause of that die-back and the effects of acid rain on those particular plantations. In the case of two other reserves, one near Wawa and one near Sudbury, where they have received direct fumigations of SO_2 and acid rain, we had a complete destruction of the birch veneer industry on one of those reserves. We have had two extensive studies that have documented the effects of that fumigation in acid rain on the particular species of plants and trees on the reserve, one by a remote sensing technique and another by ground and soil studies, snow studies, and vegetation studies.

I find it hard to quantify in dollars and cents the impact on Indian communities of those factors I've mentioned other than the commercial fishery. I think that consideration of the treaties, in this particular area of Ontario, and the impact of diet and also on the social structure of the communities, if the fish disappear or even substantially decline, is important. However, even though these are not isolated communities, their feeling for the land and the amount of time they spend fishing and hunting for recreation, for cultural considerations, and in some cases for employment, is such a substantial part of some families' lives that if fishing decreases in the lakes around those reserves, it will have a very serious impact on those communities. Eventually, Canadians will pay a price for that. All Canadians will! And again I think that is a point to bring home to the Americans, because outside of the salmon rivers on the west coast and the east coast, and some Indian fisheries around the Great Lakes, the Americans don't have a comparable situation. They don't realize that Indians in Canada live as close to the land as they do. I've been in the States and toured a lot of the reserves, especially in the

southern United States. They don't have the same relationship with the land as we do in Canada, mainly because of the number of lakes we have here, the nature of the forests, and so on. So I'm saying there is quite an impact, but I don't know how to quantify it and I don't think that it is necessary to quantify it. I think that it can be described articulately and with some emotion, whatever it takes, but I think that a good set of briefing papers for the negotiations on these points would be helpful.

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I would like to present to you the preliminary results of a survey we did in Quebec at the request of the Department of Fisheries and Oceans. It was a survey in the sector of sport fishing and we consulted management of ZECs, which are controlled exploitation zones in Quebec. Private clubs were nationalized in 1978 and they are now managed by regional associations. There are 66 of those zones and they can amount to a few hundred lakes each. We also consulted about 500 private outfitters, who are still active in many regions of Quebec and who have smaller territories, usually of a few lakes although some can go up to about 50 lakes. There will be something new in my presentation since I will make it in French.

L'Association québécoise de lutte contre les pluies acides (AQLPA) est un groupe de citoyens sans but lucratif, voué à la protection de l'environnement. L'Association a vu le jour au cours de l'été 1982 et s'est donné pour tâche d'informer le public québécois sur la gravité du problème des pluies acides.

Dans le but de mieux connaître l'état de sensibilisation du secteur des pêches sportives et d'être en mesure de répondre aux questions des pêcheurs concernant les pluies acides, le ministère des Pêches et des Océans à demandé à l'AQLPA d'entreprendre une enquête à ce sujet auprès des pourvoyeurs et des gestionnaires de zones d'exploitation controlée (ZEC) du Québec. Nous avons donc entrepris un sondage auprès des 66 ZEC du Québec et de 500 pourvoyeurs susceptibles d'être sérieusement affectés par ce problème au cours des prochaines années. Chaque envoi incluait une brochure du ministère des Pêches et des Océans, de la documentation rédigée par l'AQLPA et trois questionnaires à remplir et à retourner.

Nous avons rédigé les questionnaires de manière à obtenir les renseignements qui nous permettront d'atteindre les objectifs de connaissance et de perception du problème des pluies acides tel que vécu par les utilisateurs du milieu aquatique dans le but d'être en mesure de mieux les informer à l'avenir. Je vous présenterai aujourd'hui les résultats préliminaires de notre enquête en ce qui concerne la perception de 26 ZEC (40 %) et de 78 pourvoyeurs (16 %). Le rapport final que nous ferons parvenir au ministère des Pêches et des Océans le 31 mars fera état des indices d'acidification de l'eau déjà observés par les utilisateurs concernés et complétera le compte rendu présenté cet après-midi au niveau de la perception et des besoins des autres répondants.

Enquête sur les besoins d'information : Questionnaire A — Pourvoyeurs

La grande majorité des répondants ont déjà entendu parler des pluies acides. Leurs principales sources d'information étaient, dans l'ordre décroissant des réponses : télévision (63), journaux (53), radio (48), amis (21), gouvernement (12), et conférence publique (7). Lorsqu'il s'agit d'expliquer ce que mesure le pH, les réponses sont partagées; trente-deux pourvoyeurs ont donné une bonne réponse, 5 se sont trompés et 33 ont préféré ne pas répondre! Vingt-sept répondants savaient que la pluie tombant dans leur région pouvait être 40 fois plus acide que la normale alors que 39 l'ignoraient. Les répondants semblent cependant savoir que la neige est aussi acide que la pluie (61 contre 6).

Parmi les régions du Québec qui sont, de par la nature de leur sol, les plus sensibles aux dépôts acides, les répondants ont indiqué, dans l'ordre décroissant, la Côte-Nord à 30 reprises, le Nord-Ouest à 23 reprises, l'Outaouais 22 fois, les Laurentides (19), la Mauricie et le lac Saint-Jean (13), Québec (12), la Gaspésie (11) et l'Estrie (9). En ce qui concerne les régions qui reçoivent les dépôts les plus fortement acides, les Laurentides ont été citées à 21 reprises, l'Outaouais 19 fois, l'Estrie (17), le Nord-Ouest (16), la Côte-Nord (15), le lac Saint-Jean (7), Québec et la Mauricie (6) et la Gaspésie, 5 fois seulement. On peut donc conclure que la perception régionale de la menace des pluies acides au Québec est assez bien développée chez les pourvoyeurs interrogés.

Un lac a été reconnu par 72 répondants comme étant l'habitat le plus sensible aux précipitations acides; 24 ont opté pour une rivière, 15 pour une forêt et 8 pour un champ. La description du sort des poissons dans un lac acidifié était bonne dans 63 cas, mauvaise pour 3 et sans réponse pour 4. Quarante et un pourvoyeurs se sont dits au courant de la possibilité de traiter un lac avec de la chaux pour neutraliser son acidité; 19 d'entre eux se disent prêts à avoir recours à ce procédé alors que 22 refuseraient d'avoir recours au chaulage même si c'était la seule solution qui leur était offerte. Seulement 10 pourvoyeurs croient qu'il serait possible d'exploiter leur territoire s'ils devaient ensemencer tous les poissons qui seront pêchés par la suite, alors que 56 de leurs collègues sont convaincus qu'il ne serait pas rentable d'avoir recours à une telle pratique.

Questionnaire B — Pourvoyeurs

« Dans quels domaines souhaiteriez-vous recevoir davantage de renseignements? »

Pour répondre à cette question, un choix de huit thèmes différents était offert aux répondants. Cinquante-huit d'entre eux ont opté pour des informations sur l'acidification des lacs de leurs territoires; 51 s'inquiètent de la sensibilité des poissons à l'acidité, 46 s'intéressent aux solutions et moyens d'action, 38 au processus d'acidification des lacs, 32 au chaulage et à l'ensemencement, 31 à la sensibilisation du public, 26 aux régions fortement menacées et 21 à une description générale du problème. Les documents déjà envoyés semblent donc avoir piqué la curiosité des pourvoyeurs, alors que l'information générale distribuée a été bien assimilée.

Soixante et un des répondants se disent prêts à distribuer de la documentation sur les pluies acides à leurs clients alors

que seulement 5 ne sont pas intéressés à le faire. En ce qui a trait au type de publication, un texte spécialisé sur les poissons, les lacs et la pêche sportive a été choisi à 56 reprises, un texte général sur le rôle des citoyens et de l'opinion publique a été retenu 33 fois alors qu'un texte général sur le milieu aquatique et terrestre a obtenu la faveur de 19 répondants. Quatre personnes ont manifesté le désir d'être informées sur l'étude des plans d'eau et sur l'utilisation des appareils de mesure du pH (ces choix ont été précisés dans la case « autre »).

« Quelle source d'information vous conviendrait le mieux? »

À cette question, 36 pourvoyeurs ont dit préférer l'AQLPA (qui avait pris l'initiative de les contacter en premier lieu), 32 répondants ont opté pour le MLCP (ministère du Loisir, de la Chasse et de la Pêche, principal intervenant dans le domaine de la pêche sportive au Québec), 16 voudraient produire eux-mêmes un document avec l'aide de l'AQLPA, 14 veulent recevoir de l'information des ministères de l'Environnement du Québec et du Canada; seulement 8 personnes ont manifesté de l'intérêt pour de la documentation du ministère des Pêches et des Océans. Deux raisons semblent expliquer cette dernière réponse : le peu de visibilité de Pêches et Océans dans le domaine de la pêche sportive au Québec et le fait qu'une brochure de ce ministère sur les pluies acides faisait partie de l'envoi initial aux pourvoyeurs consultés.

« Organisation d'une rencontre d'information. »

Chez les pourvoyeurs, les réponses étaient très clairement partagées à ce sujet. En effet, 33 d'entre eux se sont montrés intéressés à organiser une soirée d'information alors que 33 autres s'y refusent, faute de temps ou de local approprié en général. Parmi les intéressés, 17 favorisent la tenue d'une telle réunion au cours du printemps, 5 pendant l'été et 7 à l'automne. Il est à noter que 4 répondants ont insisté pour obtenir une rencontre au cours de l'hiver, même si ce choix n'était pas offert dans le questionnaire.

Enquête sur les besoins d'information : Questionnaire A — ZEC

Tous les gestionnaires de ZEC questionnés avaient déjà entendu parler des pluies acides. Leurs principales sources d'information étaient, dans l'ordre décroissant des réponses : télévision (20), journaux (17), radio (14), amis et conférence (6) et autres (3). Lorsqu'on leur demande d'expliquer ce que mesure le pH, 12 répondants donnent une bonne réponse, 4 se trompent et 6 n'ont pas répondu. Onze répondants ignoraient que la pluie tombant dans leur région pouvait être 40 fois plus acide que la normale, alors que 10 le savaient et que 2 n'ont pas répondu. Vingt-deux des 23 gestionnaires de ZEC consultés croyaient cependant que la neige était acide, tout comme la pluie.

Parmi les régions du Québec qui sont, de par la nature de leur sol, les plus sensibles aux dépôts acides, les répondants ont indiqué, dans l'ordre décroissant, les Laurentides à 8 reprises, la Côte-Nord 7 fois, le Nord-Ouest (5), l'Outaouais et la Mauricie (4), Québec (3), et l'Estrie, le lac Saint-Jean et la Gaspésie, 2 fois seulement. En ce qui concerne les régions qui reçoivent les dépôts les plus fortement acides, la Côte-Nord a été citée à 8 reprises, l'Outaouais et le Nord-Ouest 7 fois, les Laurentides (6), la Mauricie (5), le lac Saint-Jean (3), et l'Estrie, Québec et la Gaspésie, 1 fois seulement. Les gestionnaires de ZEC semblent donc être en général conscients des régions du Québec susceptibles d'être les plus affectées par les dépôts acides.

Un lac a été reconnu par 21 répondants comme étant l'habitat le plus sensible aux précipitations acides; trois ont mentionné une rivière et un seul la forêt. La description du sort des poissons dans un lac acidifié était bonne dans 18 cas, mauvaise dans 3 autres. Dix-huit gestionnaires de ZEC connaissent le procédé du chaulage pour neutraliser un lac acide; deux n'étaient pas au courant, 3 n'ont pas répondu. Quatre répondants se sont dits prêts à utiliser cette méthode alors que 6 autres s'y refusent catégoriquement, favorisant un contrôle à la source des émissions polluantes. Vingt ZEC seraient incapables de rentabiliser leurs opérations s'ils étaient dans l'obligation d'ensemencer tous les poissons qui seront pêchés par la suite. Un seul optimiste s'est dit confiant de pouvoir continuer l'exploitation de son territoire dans de telles conditions. Il est intéressant de noter que 10 ZEC ont déjà recours à des ensemencements sur certains plans d'eau alors que 4 ZEC ont plutôt recours à l'aménagement de frayères ou à la relocalisation de poissons indigènes.

Questionnaire B — ZEC

« Dans quels domaines souhaiteriez-vous recevoir davantage de renseignements? ».

Vingt gestionnaires de ZEC ont accordé leur priorité à de l'information sur la sensibilité des poissons à l'acidité; 19 veulent en savoir plus long sur l'acidification des lacs de leurs territoires; 13 veulent compléter leurs connaissances générales du problème; 13 également s'intéressent au processus d'acidification des lacs; 12 veulent connaître les solutions et moyens d'action; 10 s'interrogent sur le chaulage et les ensemencements et finalement, 9 répondants voudraient se renseigner sur la sensibilisation de l'opinion publique. Les gestionnaires de ZEC semblent donc s'intéresser davantage à de l'information générale et négliger un peu les solutions et moyens d'action, contrairement aux pourvoyeurs consultés.

Vingt-deux des 23 ZEC se disent cependant prêtes à distribuer de la documentation sur les pluies acides à leurs clients, l'unique exception n'ayant pas répondu à cette question. C'est sans doute là le rôle que les ZEC sont à même de jouer dans la sensibilisation de l'opinion publique. En ce qui a trait au type de publication, un texte spécialisé sur les poissons, les lacs et la pêche sportive retient l'attention de 17 répondants, un texte général sur le rôle des citoyens répondrait aux attentes de 9 gestionnaires alors que le texte général sur le milieu aquatique et terrestre est favorisé par 7 répondants. Une autre personne indique qu'un texte axé sur la situation régionale répondrait sûrement à un besoin.

« Quelle source d'information vous conviendrait le mieux? ».

À cette question 14 ZEC ont répondu favoriser l'AQLPA comme intervenant, 13 optent pour le MLCP (qui subventionne largement les ZEC), 7 préfèrent Environnement Canada, 5 Environnement Québec, 4 souhaitent produire un document avec l'aide de l'AQLPA et 3 optent pour le ministère des Pêches et des Océans. Le peu d'intérêt soulevé par Pêches et Océans s'explique sans doute de la même manière que pour les pourvoyeurs.

Il sera intéressant de voir quelle sera la réaction du MLCP lorsque les résultats de ce sondage lui seront transmis. Ce Ministère s'est montré fort réticent à diffuser de l'information sur les pluies acides et la pêche sportive au Québec depuis que ce problème fait l'objet d'études gouvernementales. Nous croyons avoir clairement démontré un besoin d'information marqué dans cet important secteur d'activité économique. Il nous reste à espérer que les ressources appropriées seront mises à la disposition des principaux intervenants dans cet important dossier.

« Organisation d'une rencontre d'information. »

Quinze gestionnaires de ZEC se disent prêts à organiser une réunion d'information sur les pluies acides (film, discussion) avec l'AQLPA. Dix de ces rencontres pourraient avoir lieu de préférence au cours du printemps, 2 pendant l'été et 3 à l'automne. Cinq répondants se sont montrés peu intéressés ou non disponibles pour organiser une telle rencontre.

Nous avons l'intention d'offrir aux ZEC intéressées la possibilité de tenir des réunions d'information sur les pluies acides au cours du mois de mars. Nous garderons toutes les demandes de rencontres ultérieures en réserve dans l'optique d'une éventuelle suite au présent contrat. Il nous fera plaisir de participer au développement d'une vaste campagne d'information auprès des pêcheurs sportifs québécois et de réaliser tout travail que Pêches et Océans voudra bien nous confier en ce sens.

PART III — APPROACHES TO MEASURING THE VALUE OF THE RECREATIONAL FISHERY / PARTIE III — APPROCHES À L'ÉVALUATION DE LA PÊCHE RÉCRÉATIVE

Estimating the Economic Consequences of Acid Rain on Sport Fishing — An Overview

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Abstract

A simple tenfold increase in the acidic level of the lakes and rivers in Ontario and Quebec would be fatal to all aquatic life in those regions. Fish cannot survive because as acidity increases, levels of calcium drop so low that female fish are unable to develop eggs. The U.S. Environmental Protection Agency estimated in 1980 that Canada receives from the USA about 3 times the sulphuric acid and 11 times the nitric acid exposure it sends to the USA. Thus, unless something drastic is done about acid rain, of the 48 000 lakes in Ontario, more than half may end up with a pH below 4.5. For all practical purposes they will expire as aquatic biosystems in the next 20 years.

Among other effects, it has been estimated that acid rain causes approximately $1 billion of damage to our older and historical buildings and museums. The U.S. Clean Air Act of 1970 has become part of the problem in that the solution to localized pollution was to build higher smoke stacks. Not only did this distribute the effects over a wider area, but it allowed the necessary 4 or 5 days for the sulphur dioxide to acidify in the atmosphere. This has resulted in an increased acid rain problem in Canada.

Acid rain is essentially a pollution problem and may be treated as either an "externality" or "public good" (or bad). Depending on the choice of category the conclusion reached may be quite different. The former approach is the more traditional categorization, particularly in examining the benefits and costs of public investments, while the latter involves state of the art estimation of the demand for services jeopardized by the effects of acid rain. It is the treatment of acid rain as a public bad that has been the focus of research for the Department of Fisheries and Oceans. However, this approach is complex and further research is warranted.

Résumé

Une simple augmentation d'un facteur de dix du degré d'acidité des lacs et des rivières en Ontario et au Québec serait fatale pour toute la vie aquatique dans ces régions. Les poissons ne pourraient survivre parce qu'à mesure que l'acidité augmente, les niveaux de calcium baissent à tel point que les femelles ne peuvent produire d'œufs. La U.S. Environmental Protection Agency a estimé en 1980 que le Canada reçoit des États-Unis environ trois fois plus d'acide sulfurique et onze fois plus d'acide nitrique qu'il n'en envoie sur le territoire américain. En conséquence, à moins d'imposer des mesures radicales de lutte contre les pluies acides, le pH de plus de la moitié des 48 000 lacs ontariens pourrait descendre au-dessous de 4.5. À toutes fins pratiques, ils disparaîtront comme écosystèmes aquatiques au cours des vingt prochaines années.

Entre autres effets, il a été estimé que les pluies acides causent environ un milliard de dollars de dommages à nos vieux immeubles historiques et à nos musées. Le U.S. Clean Air Act de 1970 a aggravé le problème par le fait même que la solution à la pollution localisée était la construction de cheminées plus hautes. Non seulement les effets ont été disséminés sur une plus vaste superficie, mais cette situation a rendu possible l'acidification du dioxyde de soufre, qui nécessite une période de 4 à 5 jours. Le problème des pluies acides au Canada est ainsi devenu plus complexe.

Les pluies acides sont essentiellement un problème de pollution, qui peut être considéré soit comme un « coût externe » soit comme un « bien ou un mal public ». Selon le choix de la catégorie, les conclusions peuvent être très différentes. La première approche est la catégorisation la plus traditionnelle, particulièrement si l'on examine les avantages et les coûts des investissements publics, tandis que la seconde comporte l'évaluation, au moyen des connaissances actuelles, de la demande de services menacés par les effets des pluies acides. C'est le traitement des pluies acides comme conséquence nuisible pour le bien public qui a constitué le principal objectif de la recherche du ministère des Pêches et des Océans. Cependant, cette approche est complexe et d'autres recherches complémentaires sont justifiées.

When one attempts to provide an overview of anything, there is always the danger of becoming too simplistic or too general in one's approach. This danger is counterbalanced, however, by the danger of omission and commission; that is to say that neglecting important aspects of the issue or taking a firm and committed position regarding one particular solution is just as much of a danger. In this paper, I intend to: one, review briefly the acid rain problem as an ecological system problem in order to develop a global view; two, review briefly the acid rain sport fishing problem as an economic classification problem, namely, whether it is an externality or a public good; and finally, review briefly the methodology problem of the acid rain effects on the sport fishing issue.

Acid Rain as an Ecological System Problem

First, the acid rain as an ecological system's problem. As all of us know from various scientific reports published in the last few years, most of our lakes in Ontario and Quebec will be dead within the next 20 years due to acid depositions, unless something is done about it within the near future.

Acid deposition or, as it is called in the popular literature, acid rain, may be either wet or dry. In wet deposits, the typical deposits in the Ontario–Quebec region, acids are collected from the atmosphere by rain, fog, snow or other forms of precipitation. Dry deposits come from acidic dust or gases that fall from the atmosphere during dry periods. The

acidity level of water is measured on a pH (that is, potential for hydrogen ion concentration) scale, and the range is 0 to 14. Pure water has a pH value of 7 and alkaline solutions are above 7, while acidic solutions are below that number. The scale is logarithmic; thus a decrease of 1 point, for example from 7 to 6, represents a tenfold increase in acidity. Unfortunately, in contrast to popular belief, rain, water and snow, even when falling from a clear atmosphere, is not neutral but is acidic. It's about 5.6 on the pH scale. Remember 7 is neutral. And thus some of the acid rain effects have been a fact of life for a long time. Admittedly, the acidic effect in this case is not due to either sulphuric or nitric acid, but only due to carbonic acid, which is the product of normal interaction of carbon dioxide and water in the atmosphere. Thus, for practical purposes, we should talk about the effects of acid rain only when precipitation has a pH level below 5.6. Just as a point of reference, we should mention here that all aquatic plant and animal life disappears below the 4.5 pH level, so the critical range is within one order of magnitude of the pH level of the minimally contaminated acid rain. A simple tenfold increase in the acidic level of our lakes and rivers in Ontario and Quebec would be fatal to all aquatic life in that region. Fish cannot survive because of chemical interference with their reproductive cycle. Due to acidity in the lakes, the calcium levels drop so low that the female fish is unable to develop eggs. Different species have different acidity tolerance. The smallmouth bass, for example, stops reproducing below 5.5 pH, but the yellow perch reaches this state only at 4.5. I only mention these specifics because when you do economic studies of different kinds of species, if they react differently, the variables have different tolerance levels. But no fish can reproduce below 4.4 pH, and the various planktons that are crucial elements of the aquatic food chain also die at the same 4.4 pH level, as do pond weeds, reeds, and other larger plants.

High acidity levels in lakes and rivers represent another danger for the aquatic ecology. Aluminum and other heavy toxic metals, for example, mercury, lead, and manganese, get dissolved by acids and appear in poisonous concentrations in the water. It is true of course that not only the fishes are affected by acid rain, but the wildlife of birds and mammals as well, which depend directly or indirectly upon the fish as a source of food. Acidic contamination is a specific danger to human health as well, because in turn we may consume plants, fish, and animals with a toxic concentration of metallic poisons and indeed draw our drinking water from lakes and rivers and shallow wells that have a higher than safe concentration of lead, copper, and metals leached from the soil or the plumbing system.

Our trees and forests are not spared the effects of acid rain either. It has been found that treetops may decay and spruce trees lose their needles because the soil is becoming increasingly acidic. In the soil, sulphates combine with calcium and magnesium, and these useful minerals get eliminated as a source of plant food. Consequently, the trees must use up their internal calcium and the process of decay, starting at the treetop, begins. Furthermore, as aluminum and heavy metals, dissolved by acids from the soil, enter into the root systems of the trees, they destroy the tiny feeder roots and thus greatly expedite the decay process.

Now that we've briefly viewed the ecological effects of acid rain, we may well ask about the causes. There are several natural causes, of course, such as volcanic eruptions, forest fires, hot springs, geysers, decay of organic matter, and sea sprays, but they are neither ongoing nor highly concentrated explosions, and thus, for the most part, nature has a way of neutralizing them.

The real increase in acid rain depositions in the past fifty years has come from man-made causes, namely from our burning fossil fuels to provide power for our industries. Emissions from electric utilities, metal smelting, and other industrial processes generate sulphur dioxide, which becomes sulphuric acid in the atmosphere and represents the major part of our acid rain problem. The other offender is nitric acid, which is part of the exhaust products of automobiles, trucks, and other vehicles. Both of the nitric and sulphuric pollutants are strongest in the heavily populated and industrialized eastern half of North America.

In this geographical area, the prevailing winds blow northeast from the southwest, and Canada receives a major proportion of the acid pollution. The U.S. Environmental Protection Agency (EPA) estimated in 1980 that Canada receives from the U.S.A. about three times the sulphuric acid and eleven times the nitric acid exposure it sends to the USA. This transborder traffic of acid pollution, of course, causes political problems between the two countries that are beyond the scope of this paper. But to put this problem into perspective, we should note that the Ontario Ministry of the Environment estimated that of the 48 000 lakes in Ontario, more than half may reach a pH level below 4.5 and thus for all practical purposes will expire as aquatic biosystems in the next twenty years unless something drastic is done about acid depositions now.

The problem is not limited to aquatic ecosystems or to the maintenance of human health, either. Our historical heritage is threatened by acid rain as well. In Canada, limestone, marble and sandstone have been widely used for statues, monuments and buildings; these contain calcium carbonate, which is converted to gypsum (calcium sulphate) when exposed to sulphuric acid. But gypsum is not a strong structural material, as you know. It dissolves in water and falls apart easily. It has been estimated by Heritage Canada that acid rain causes approximately $1 billion worth of annual damage to our older and historical buildings and monuments.

Incidentally, while acid deposition is a universal problem, the eastern region of North America is more affected by it than the western region because in dry climates, alkaline dust is blown in the atmosphere from the surface of the soil, which tends to neutralize acidic contamination of the atmosphere. This does not happen in wet climates; in fact, the problem is actually enlarged here if the winter climate is cold, because all the acid-contaminated snow piles up on the frozen lakes and soil during the winter and suddenly melts in the spring, providing an "acid shock" to our aquatic ecosystem not unlike the "chlorine shock" that we apply to our swimming pools. The acid shock in the spring can easily lower the pH level to 4.8 temporarily in our exposed lakes; while this effect is only temporary, spring is the time when fish eggs hatch, and we could lose our whole fish crop in that lake in a couple of weeks. Thus the acid rain is a serious and growing ecological problem that affects man and his environment negatively.

Now that we have acquired an understanding of the problem, we may ask ourselves what can be done about it. There are some obvious solutions. We could attempt to neutralize the acid deposits by spraying the lakes and their watersheds

with alkaline material, namely liming solution, but this is not a very practical remedy, partially because of the inaccessibility of a lot of our lakes and surrounding areas, and partially because of the great number of them. Furthermore, the liming up of the lakes and waterways would only neutralize the acidity, it would not eliminate the contamination of toxic materials that are already dissolved in the lakes.

This leaves us with various methods of eliminating the pollution at source, all of which are very expensive. According to experts, the most effective solutions in increasing order of effectiveness would be the following: (1) To use low sulphur coal available in the west instead of the high sulphur coal which is readily available in the east for the industrial processes which require coals as a fuel ingredient; (2) To crush and wash the available eastern coal prior to usage. This could eliminate about 40% of the sulphur content; (3) To spray the flue gas with a semifluid slurry of limestone and thereby desulphurize the exhaust gas. This could eliminate about 90% of the sulphur content from the product, as the resulting solid calcium sulphite or sulphate can be easily disposed of.

Clearly, some type of government intervention through tax or subsidy would be necessary to bring about this change, as the introduction of these measures could easily increase production costs by 15–20%, and the utilities, plants, and factories of the region are not likely to absorb this extra cost voluntarily. One could, of course, always hope that legislation is an alternative solution to the problem, but ironically, in this case, protective legislation is part of the problem, not part of the solution. The U.S. Clean Air Act of 1970 and the following amendments in 1977 did indeed limit sulphur dioxide emissions locally. But as the objective of that legislation was only to protect the residents of these areas from unsafe levels of sulphur dioxide exposure, one obvious solution for the culprits was to raise the height of their smokestacks and thus pump the exhaust gases into the higher atmosphere. The wind then blows away the pollutants and the exposure of the local residents to these pollutants is reduced. Indeed, many, many such smokestacks were built in the 1970's and they did satisfy the regulations of the Clean Air Act. The real irony is that it takes time, about 4–5 days, for the sulphur dioxide to acidify and become sulphuric acid in the atmosphere, time which the exhaust gases did not have when the chimneys were shorter but time which is now virtually guaranteed because of the injection of the exhaust gases into the higher atmosphere.

So the Clean Air Act was clearly not the product of a complete systems analysis of the pollution problem, but only an apparent solution to an apparent problem. It is a common error against which we must guard ourselves when studying the effects of acid rain on sport fishing. Acid Rain has an effect on the whole aquatic ecosystem and not only on the specific species of fish that sport fisherman cultivate. It has an effect on the recreational activities not only of fishermen but many others who choose lakes and their physical environment as their favourite spot for rest, recreation and relaxation.

The Problem of Economic Classification

This brings us to my second point: from the system level to the economic level. What I would like to address now is the problem of economic classification. The acid rain problem is essentially a pollution problem, and as such it may be treated economically either as an "externality" or a "public good." I suggest to you that the treatment and the conclusion which one may reach could be quite different depending on this categorization. If it is to be handled as an economic externality, the principles of welfare economics will be our guide. On the other hand, if it is to be handled as a public good, the principles of consumer economics and price theory will serve as our guide.

If the acid pollution is an externality, i.e. a spillover effect or third party effect, then only technological changes and not pecuniary changes will concern us. The first party would be, for example, the electric utility which generates coal-based electric power. The second party would be a group of electricity consumers in the region to whom electricity is sold by the electric utility. And the third parties who were not party to the original transaction, of course, would be the recipients of the byproduct: acid rain. As typically is the case, they are separated from the original transaction both in time and space. According to the current wisdom of welfare economics, the coal-generated electricity project is justified if the net benefit is positive; that is, if the net benefit realized by the parties of the original transaction is greater than the loss realized by the sufferers of the third party effects of acid rain then the project is economically feasible. In welfare economic jargon, the Hicks/Kaldor criterion applies, a criterion which states that the policy should be accepted if those who gain by the policy could fully compensate those who lose by the policy with some surplus remaining. Note that the compensation does not have to take place. It is sufficient to determine that the gainers could potentially, I repeat potentially, compensate the losers.

Thus, if the issue of acid rain were studied as an externality, we would attempt to assess the third party social costs and social benefits in addition to and relative to the direct costs and direct benefits of the first and the second parties, and we would concentrate on identifying and quantifying technological spillover effects only, albeit with the perception of their being of secondary importance to the original transaction costs. We would be concerned with estimating the total cost of compensation for the externality and would attempt to internalize the externality in the original cost-benefit analysis. If the project were cost-beneficial, having incorporated the estimated third party effects (and we would estimate the costs as the cost of neutralizing the regional primary cause of the externality at source), we would give it our blessing and assume that society later will find a way to compensate for the losers through a redistribution of income or wealth, should it find such a step warranted.

On the other hand, if we were to treat the various effects of acid rain as a "public good," or public "bad" in this case, we would be compelled to estimate the various negative impacts of acid rain pollution on our various economic activities and welfare. Hence we would move to the application of various economic models, which would estimate the costs for us. And this movement leads us to the arena of methodological concerns, the third and the last part of my paper which we shall review now briefly.

The Methodology Problem

Consumer preferences for public goods, such as acid rain-free lakes and rivers, cannot be directly observed in the marketplace, but as we need to develop an understanding of the public's assessment of values in this area in order to

develop or suggest modification to existing policies, we must attempt to estimate these relationships indirectly or through proxies. The current state of the art in recreational benefit evaluation distinguishes among three approaches, and the Department of Fisheries and Oceans, in my opinion very appropriately, commissioned a comprehensive study to apply all three of these approaches to a specific Ontario region. The decision to utilize all three approaches was appropriate because the jury is still out and deliberating on the question of the accuracy, reliability, and cost-effectiveness of these methods. Each of these methodologies and models has weaknesses and possibly debilitating assumptions, but they are the best we have at this time, and the current state of affairs is much superior to that of only ten years ago, when it was assumed that these so called "intangible values" could not be estimated in any systematic way.

Thus, in short and in general terms, what these methods have in common is that they aim to develop a derived demand function curve for the public good of acid rain-free lakes and rivers, in order to estimate the direct benefit of such an ecological phenomenon accrued to the public as measured by consumer surplus. Two of these methods attempt to reach a conclusion based on an assessment of the public's willingness to pay for this good, and the third method incorporates, in addition to that component, the public's willingness to accept a fair compensation for the loss of this good.

The three leading methods referred to above are:

1) the contingent valuation method;
2) the travel cost (or Talhelm) method; and
3) the hedonic price method.

In the following I wish to give my personal comments on each of these three methods.

The Contingency Method

The "contingency" method is essentially a questionnaire method, asking for public response to specific questions attempting to measure either the public's willingness to buy this "public good," (that is, willingness to pay, measured in compensating variation) or the public's willingness to sell this "public good," (that is the willingness to accept as fair compensation measured in equivalent variation). The form is either a questionnaire, or a referendum type of instrument in which alternative contracts are offered and bid on, on an iterative basis.

The problems here, in my opinion, fall into the following three catogories. I chose to use the labels which the literature uses, namely strategic bias, hypothetical bias and information bias, but I developed a much more extensive list of points under these headings than customary.

1. Strategic Bias

The so-called strategic bias problem, of course, is the gamesmanship problem that is involved in every contractual process. Individuals who are not directly involved, that is, they don't have to put up any money, may consciously overbid or underbid the case, depending on their belief that there will be a change in policy as a result of their bidding. If they believe that an acid rain control policy will be introduced anyway then they underbid, so that if it turns out to be the correct situation, they won't be overtaxed. If they don't believe that there will be a change of policy, then of course they overstate the case, either to indicate the government's current irresponsibility in this matter or to induce corrective action, which in their opinion would not otherwise be forthcoming.

2. Hypothetical Bias

The hypothetical bias has essentially four categories. The *first* is that the situation is not real, and therefore anything goes. Bids without actual payments don't mean anything, and people therefore can live out their fantasies. Some of the studies in the literature indicate that that is not a serious threat, but I had an opportunity to review the questionnaires which we handed out on a pilot study; those of you who had the same opportunity, I think, have also concluded there is quite a variety of individual assessment as to what people are willing to contribute or how much it is worth to them. So in fact, there is some political involvement.

The *second* category of hypothetical bias is that there is no real-life experience involved in bidding for hypothetical goods and services. This has three dimensions. The one dimension is that there is a false choice being made, because it is a complex decision problem, not with a simple binomial outcome, namely either in favour of it or against. Not having any experience with it, it is an arbitrary choice which is being offered. Secondly, there is a transitivity problem. To illustrate this point let us imagine that you are being asked if you prefer apple pie to bean soup and you say you prefer apple pie, and then you are asked if you prefer bean soup to toast with caviar on it, and you select the bean soup, then logically you should prefer apple pie to toast with caviar on it. But when you are asked to verify your preference of apple pie over the toast with caviar, you reply, I'm not so sure, I think I prefer toast with caviar to apple pie. This is an unexpected and illogical answer; it is a transitivity break-down. This again is because we don't have experience with that kind of thing, it's only hypothetical. And finally, still in the area of lack of real-life experience, there are memory fault problems. Since this is a hypothetical example, there is no compulsion on our part to remember these things, so the details would be false, under- or over-stated, with regard to cost, experience, time delays and the like. We have actually no reason to remember in detail because it's a hypothetical situation.

The *third* major category under hypothetical bias, of course, is the attitude versus the actual behaviour bias. As we all know, what we say and what we do are not necessarily the same. This is especially so in an area in which choices are hypothetical and not real.

The *fourth* problem area is that there is inconsistency in areas in which one must make trade-off judgements between quality and quantity. People's choice would depend on inherent, intangible and individual values associated with these trade-off attributes, in our case, the size, number and type of fish that they may catch as a result of a deacidification program of our lakes and rivers. For example, ten small fish are not the equivalent of one big fish, although the full lengths and the weight of ten fish may be exactly three feet and ten pounds, respectively, and the one fish is also three feet and ten pounds; but you know that the trade-off values are not very clear in people's minds.

3. Information Bias

The third category of bias is information bias, and an obvious one is of course the "starting point bias"; that is, we

either start with the status quo or some other arbitrary value, suggested initially values that may influence the decision maker's position. Secondly, we have "vehicle bias," that is, we refer to some preferred or not preferred kind of vehicle, such as taxation, as the method that is likely to be used for accomplishing the change. This again will introduce some kind of very strong reaction to the proposition. Thirdly, there is the "survey instrument bias"; the way we ask the questions, the way we sequence them may be ambiguous, incomplete, misleading, or biased, and influence the way people process them.

Then there is "lack of information bias." People may not know at all what we talk about, or they misunderstand ambiguous, or they are naive about it, and therefore will provide only vague answers or guesses in reply to the questions asked. Finally, there is "communication bias." The interviewees may provide false answers, either because they consider the questions an intrusion on their privacy or because they wish to protect the privacy of the information that is being sought (e.g., the location of their favourite fishing spot). Furthermore, it's very difficult, as the literature clearly indicates, to communicate about abstract concepts. In fact, some reseachers believe that we must handle out photographs so people would have some ability to measure the aesthetic value of changes, because one couldn't just describe it satisfactorily in a verbal format.

The Travel Cost Method

This brings me to the second matter which I would like to comment on, which is the Talhelm travel cost method. In my opinion, the typical limiting assumptions of this model are the two-dimensional utility functions, namely the *ceteris paribus* condition for tastes, preferences, incomes, substitutes, complementary goods and services and even technological change. Of course this is not unique to this method. Most demand estimation procedures suffer from the same kind of disadvantage, but nevertheless this is a serious disadvantage in a milieu in which people's assessment of value changes very fast.

The second problem I see with this method is that the model is based on differential travel distances between optimum and second best choices. The incremental cost is expressed in terms of vehicle and other incidental travel costs, and opportunity costs for productive time given up for the trip. But several technical problems arise here. For example, should the time cost be half or one-quarter of the wage rate, based on the possibility of giving up a second job for the individuals who travel, or should it be one and a half times the regular wage rate, on the argument that what he is giving up actually is overtime, and overtime is paid at one and a half at the place where he would be working? Is the actual trade-off between working and the trip, or between the trip and another leisure activity, thus, is he really giving up working extra hours or is he giving up watching TV? Perhaps the opportunity cost of the second-best recreational activity should be used and not an estimate of lost wages. Should the total trip time be counted or only the actual travel time? Some people travel only a short distance to their destination but stay there for a significant time. Currently we only allocate the actual travel time. Should the allocated vehicle cost be just a marginal vehicle cost for this trip or the pro-rated average cost of the wear and tear and maintenance, of the vehicle?

Thirdly, it is assumed that the subject derives no utility from the travel itself (for example, the scenery, the companionship of family or fishing friends do not provide any additional pleasure), and that these trips typically have only one single purpose for all members of the party, namely fishing. It ignores the joint or the complex combinations of vacation aspects, aspects of visiting relatives or friends, and other potential goals and accomplishments such as renovating the cottage while we are fishing, or repainting the boat.

Fourthly and lastly, the product class definition and the assumed marginal utility function are rather artificial ones and as such they may not correspond to the user's perception of the "fishing product". For example, the utility of a specific type of fish versus another, small fish versus big fish, few fish versus many fish, etc.

On the whole, the travel cost method is a useful and operational method estimating public demand for a set of fishing products, but as may be seen from the questions raised above, it is far from being a universal and uniform technique of assessment.

The Hedonic Cost Method

And finally this brings me to the third method, the hedonic cost survey method. This approach is based on the concept of demand for the characteristics of a public good rather than a demand for the good itself. The basic rationale behind the hedonic cost technique is imputing a price to a characteristic by observing the behaviour of consumers who attempt to obtain more of the said characteristic. Thus, it is based on observed behaviour that reveals preference. The technique has been successfully used in air and water quality studies, in pollution controls for households, using various characteristics which are related to the public good. In the acid rain problem we could apply the same or several other explanatory variables such as distance travelled by sport fishermen, or their expenditure on fishing equipment such as boats, rods, reels etc., even changes in property values of houses that are located on the shores of acid-contaminated lakes.

Because the approach is based on observing behavioural responses to the studied effects, it is limited to estimating willingness to pay for perceived effects only in improved fishing quality.

The technique is applicable when individuals have a choice in their effective consumption of a public good and they may therefore select a specific bundle of private goods in association with the public good in question. Essentially, first we estimate the implicit prices of the characteristics that differentiate related products. This we call the hedonic price function. And then we regress the implicit prices statistically, or econometrically if you will, against observed quantities, in order to estimate the demand function itself. This technique assumes that the utility function is separable in the chosen characteristic, that we are able to develop an inverse demand function for individuals and that those are identifiable. And it will only work if the implicit price function is not linear in the quality assessment variable, that is, the acid rain exposure of the lakes in question. Therefore, this technique is not universally applicable.

This technique is also subject to the *ceteris paribus* assumptions which we listed earlier, in the Talhelm approach, and its validity is a function of the power of the explanatory or the characteristic variable chosen. If there is a high correlation between the characteristic variable and fishing behaviour, the estimate will be reliable. If there isn't, it won't

be. The possible advantage of this method over the previous one is that it uses standard econometric techniques, and the derived demand curve is therefore an objective extension of the collected data.

In conclusion, as we said before, none of these techniques are perfect in terms of their ability to model reality, but they do represent major improvements over our past impotence in the assessment of value of recreational public goods. Thus, in my humble opinion, we should keep at it and attempt to improve these techniques further so that one day we could say with the same confidence, to any policy maker in the public sector, as our colleagues are able to say in the private sector, that while the issues contained in this project and the calculations leading to a conclusion are very complex, there is a bottom line: this project will cost us X dollars but it will generate Y dollars of benefits.

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Acid Rain and the Measurement of Fisheries Losses: A Summary of Some Issues

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Abstract

Although desirable, explicit and complete valuations of all losses, in easily comparable units of monetary measurements, is not at present a reality. Many of the most important losses involve non-market resource uses that in fact have no direct pecuniary measure, necessitating the use of indirect measurements based on underdeveloped or unsatisfactory techniques. Further, in addition to those tangible losses, such as reduced crop and forest yields, there are real losses in welfare to others in Canada whose livelihoods may not be affected but who feel the loss all the same.

If the impacts on welfare are to be quantified they should represent the amount of compensation necessary to leave each individual as well off as if the acid rain problem did not exist. This is consistent with the normal (Pareto) standard. However, the alternative measure of willingness to pay is generally more convenient to obtain, and therefore used, although current evidence indicates that it appears to substantially underestimate the value of the welfare losses.

Confusion over resource valuation issues appears to have been generated in the past by various expenditure surveys. Expenditures surveys do not measure the value of the fisheries resource. The various techniques that do measure resource value fall into two groups. The first group models the revealed preferences of resource users and includes the travel cost method. The second group which includes the contingent valuation method, measures the direct responses of individuals to choices among contingencies.

Résumé

Bien qu'elles soient sans aucun doute très souhaitables, les évaluations explicites et complètes de toutes les pertes, en unités de mesures monétaires facilement comparables, ne sont pas encore une réalité. Un grand nombre des pertes les plus importantes sont liées à des utilisations non commerciales des ressources, qui en fait ne peuvent être évaluées directement sous un angle pécuniaire, nécessitant l'application de mesures indirectes basées sur des techniques insuffisamment mises au point ou insatisfaisantes. En plus des pertes tangibles, comme la réduction des récoltes agricoles et forestières, il y a des pertes réelles sous forme de bien-être subies par d'autres Canadiens dont les moyens de subsistance ne sont pas nécessairement touchés mais qui en ressentent néanmoins le contrecoup.

Si l'on veut quantifier les effets sur le bien-être, ceux-ci doivent représenter la quantité de compensation nécessaire de façon à permettre que chaque personne jouisse du même bien-être, comme si le problème des pluies acides n'existait pas. Ceci est conforme à la norme habituelle (Pareto). Cependant, la mesure de rechange qui est de consentir à payer est généralement plus facile à appliquer et, en conséquence, utilisée, bien que les données actuelles indiquent qu'elle semble sous-estimer considérablement la valeur des pertes de bien-être.

Divers relevés de dépenses effectués dans le passé semblent avoir semé la confusion autour des questions d'évaluation des ressources. Les relevés de dépenses ne mesurent pas la valeur des ressources halieutiques. Les diverses techniques qui mesurent la valeur de ces ressources se répartissent en deux catégories. La première est une modélisation des préférences déclarées des utilisateurs de la ressource et comprend la méthode du coût de déplacement. La deuxième catégorie, qui inclut la méthode d'évaluation des imprévus, mesure les réactions directes des particuliers à la sélection d'éventualités données.

Clearly, there are changes in the well-being of people that are brought about by or are associated with, continuing depositions of what is now commonly referred to as acid rain. It is also apparent that some accounting of the extent of such welfare changes would better assure that the impact were recognized and were weighed in policy and negotiating positions.[1]

While no doubt desirable, explicit and complete valuation of all losses in easily compared units of monetary measurements is not a present reality. Nor is such a valuation likely to be done quickly and to the complete satisfaction of all. Many of the impacts of acid rain affect values that are not measured in readily available and commensurate terms. In particular, many of the most important losses involve non-market resource uses that have no direct pecuniary measure. Further, the non-pecuniary nature of these welfare changes necessitates the use of indirect measurements, and the techniques for doing this are not well developed or completely satisfactory. The barriers to obtaining explicit and complete valuations of all losses may not be prohibitive, but they are substantial. Further, the existing uncertainties over the physical consequences of varied pollution levels are likely to remain. In spite of this, it is likely still possible to gain useful insight into the values attached to losses, provided that caution is exercised and that careful attention is paid to what is to be measured and the potentials and limitations of the various methods.

Losses associated with pollution are not limited to such direct injuries as reduced yields of agricultural crops and forests, damages to buildings and other materials, reductions in fish populations, and increases in health expenditures. These costs are a part, and may well be a major part, of the total loss. But also to be included in a more complete assessment are the losses in welfare to those outside of areas directly affected by acid deposition. They may not bear the

[1]More detail of issues related to evaluation of fisheries resources and further references are provided in J. L. Knetsch, "Costs and benefits of fisheries habitat: some notes on evaluation issues," a paper prepared for the Department of Fisheries and Oceans, 1983.

direct burdens of decreased productivity or increased expenditures, but they are affected nonetheless.

If the impacts on welfare are to be put in convenient monetary terms, they should normally be expressed as the amount of compensation necessary to leave each individual as well off as he or she would be in the absence of the pollution. This minimum sum demanded to accept a change is the generally accepted economic measure of the loss in well-being brought about the action. This definition of loss is consistent with the normal (Pareto) standard that an action should be judged to be efficient and taken to add to the level of community well-being only if the gains to those made better off are greater than the sums necessary to leave the losers as well of as they were before the change. The latter measures the loss in terms of the sacrifice of other goods and services which can be used to yield satisfaction equivalent to that lost because of the change.

Although the compensation measure is usually acknowledged to be the appropriate economic measure of a loss in welfare, an alternative is often used in practice, primarily because of estimating convenience. This alternative basis for assessment is the maximum sum individuals would pay to avoid the loss.

The justification for using the "willingness to pay" measure rather than the more correct compensation demanded measure has turned largely on the presumed equivalence between them. The validity of this assumption has, however, not yet been demonstrated in any empirical observations; indeed in nearly all tests it has been shown to be seriously in error. Current evidence suggests that willingness to pay estimates seriously understate losses, with the compensation demanded measures commonly being from 3 to 10 or even 15 times larger![2] The evidence of an apparent large disparity between the measures continues to be a major issue in valuation exercises — one that will need to be resolved or accommodated if the measures are to receive full credence.[3]

The primary reason for the large disparity between the measures appears to be that people do not value changes along some smooth function, as assumed in most economic analyses. Instead, changes are valued in terms of gains or losses from some reference level. Losses taken from this reference point are consistently valued more heavily than gains beyond this point — "the aggravation that one experiences in losing a sum of money appears to be greater than the pleasure associated with gaining the same amount."[4]

In choosing the measure appropriate for specific cases, frequent references are made to property rights or entitlements as the basis for making the choice.[5] The compensation measure is the suggested choice when the degradation is legally prohibited, and the willingness to pay is the favoured measure when the law is permissive with respect to the activity causing the degradation.

The criterion of legal entitlement appears, however, to have little to do with the issue of the appropriate choice. Entitlements or lack of entitlement may set constraints on remedies available to people, but actual feelings of injury or losses in welfare are clearly not dictated by legal rules. More appropriately, losses from the reference point are best measured by the compensation demanded, as suggested by the Pareto criterion, regardless of property assignment.[6]

The compensation demanded measure, while generally agreed to be the appropriate basis for economic assessments of losses, does assume that individuals can in fact be compensated for losses by some finite number of dollars, and that restitution can be made by money payments. Although the notion of trade-offs is fairly standard in economic analysis, there may well be a problem with the use of such measures for some losses.

People seem unable to name any specific sum of money that they would trade for their health, for parts of their bodies, or for hardships inflicted on family members, for example. In spite of the fact that people make almost daily choices among more or less risky jobs and transport modes, and between more or less healthful lifestyles, the idea of stating an agreeable amount of compensation for health losses is not one that most people can accept or comply with. For some losses, many people would likely feel the idea of a trade is not "legitimate"; it is, for them, outside the easy metric of the usual economic assessment.

Although it is clear that some losses may not lend themselves to economic measurement, it is also clear that many others do. There may be still other losses, however, that fall into some "grey area," where further investigation is warranted, and where particular care is needed to obtain meaningful and useful measures.

Circumstances that require giving up fishing opportunities or "clean air," may well be troublesome, especially if this is seen to benefit people who do not evoke particular sympathies in those making the sacrifice. Certainly further testing of methods to overcome or minimize any such problems is warranted.

Another issue worthy of more concern is the very different valuations given to risks that are in fact identical, but which are perceived to be different. For example, the risk of more pollution adding further to the chances of resource deterioration is taken to be less important than being burdened with an initial risk of such harm. In the first instance there is already a chance that a loss will occur; the risk that is introduced merely increases that chance. In the second case, a risk of loss is introduced where none previously existed. Evidence suggests that people consistently place great importance on being certain that some ill will not befall them, and they will value the loss of that feeling of certainty by an amount that is far higher than the value they attach to assuming additional risks of the same magnitude once the feeling of certainty has been broken or violated. The values seem not to be a simple linear function over degrees of uncertainty. Not only is uncertainty about the effects of pollution itself a cost of the pollution, but an additional burden of cost is imposed when people see the pollution as bringing about a potential for loss that was previously not anticipated.[7]

The loss of well-being suffered as a result of the introduction of a new risk, or at least the perception of a new uncertainty, may be greatly influenced by knowledge and

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[2]See, for example, Schulze et al. (1981). Other results using real exchange experiments, which are consistent with the numerous studies using contingent valuation methods, are reported in Knetsch and Sinden (1984).

[3]One series of experiments has indicated that people acting as advisors for third parties do not value losses differently even though they do so when making choices for themselves. See Marshall et al. (1986).

[4]D. Kahneman and A. Tversky. *Econometrica* 47: 263 (1979) at 279.

[5]A recent example is provided by the British Columbia Utilities Commission, *Site C Report*, Vancouver, 1983.

[6]This is discussed further in Knetsch (1983b).

[7]See also Thaler (1980).

information. Losses are no doubt increased by the fear of uncertain consequences. Further discovery of cause-and-effect relationships and dissemination of such information by trusted purveyors — a major problem with most current sources — will therefore likely lead to smaller perceptions of loss. However, to the extent that consequences remain uncertain, or people perceive themselves to be at risk as a result of pollution discharges, the element of uncertainty remains a contributing factor to the welfare loss suffered by people and it therefore is a further cost of the pollution.

Currently available methods and techniques of nonpecuniary loss measurement fall far short of what might be desired. Yet, with little doubt much can be learned with present means, and it is a "counsel of perfection" to delay all assessments until more fully satisfactory methods are developed. This is not, however, to suggest that further refinement, testing for suitability to current problems of fisheries losses, and comparisons between methods are not worth pursuing before more general assessments are attempted.

A good bit of confusion over resource valuation issues seems to have been generated in the past by the proliferation of various expenditure surveys, and the mis-use of the data derived from them. Aside from the small portion of possible income payments stemming from expenditures by foreigners,[8] the expenditures of, for example, anglers, do not measure the value of the fisheries resource. An accounting based on users' expenditures would lead to a greater value being placed on more distant fishing opportunities than on closer ones of equal quality. Such a result would be exactly the reverse of reality.

The continuing collection of expenditure data seems mainly to serve the dubious purpose of self-serving pleadings of special interest groups. It does little to measure the losses in welfare that might be associated with the deterioration of resources.

The various techniques that do yield resource values fall roughly into two groups. The first includes the travel cost method, together with its variations and various hedonic price techniques. All build on some form of direct evidence of observed expenditure or behavior — on preferences as revealed by people in their actions. That is, in each of these cases the desired measure is derived from, say, actual expenditures that people make. The second general group consists of more direct measures of individuals' responses when they are confronted with choices among various contingencies that include more or less of the resource services being valued.

The principal advantage of the first group of methods, those based on evidence of revealed preferences, is that actual, rather than hypothetical, behavior is used as the primary data and the resource valuations are derived from relationships between these actions and the quality of the resource being valued. They build on what people actually do with respect to making choices involving trade-offs, rather than what they say they will do.

A difficulty with these methods is that they can only be used to derive what are essentially willingness to pay measures.[9] They do not provide estimates of true compensation demanded values.

Some of the techniques have been in fairly common use — the travel cost method, for example — and the data requirements and the limitations are widely appreciated. Others, including some applications of hedonic price techniques, are less well known. Relationships between land values and environmental amenities, the most common application, are generally understood. But the link between other purchases and site attractiveness may be less well appreciated, and may well be more demanding of data.

While the contingent valuation approaches can be used to estimate both compensation demanded and willingness to pay values, they are not without potential problems. Aside from generally appreciated difficulties of possible hypothetical, instrument, and strategic biases, there may also be an issue of what meaning can be attached to the responses. There is, for example, some concern that expressions of minimum compensation demands (or, alternatively, maximum willingness to pay sums) may reflect respondents' feelings of what they regard or believe to be a "fair" trade. This may or may not correspond to the desired valuation.

Many past studies have used either open-ended survey or sequential bidding formats to elicit responses, with the latter generally much preferred. The main grounds for the choices are that people have great difficulty stating a specific sum in cases of unfamiliar trades and that they can more easily express a simple preference for one option over another.

A closed-ended format has been less frequently used in the past, but offers substantial advantages over others. It has the benefit of the simple choice posed by the sequential bid format without its worry of respondent fatigue and much less of its concern with starting-point bias. This method requires a larger sample, but each response is quick and easy and the answers may well more closely reveal measures of changes in welfare.

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[8]And even here the total cannot be counted. Only the change in income payments received as a result of any depredation of the resource should be counted as a cost.

[9]This is not strictly correct as some corrections for income or wealth effects can be made. But as a practical matter compensation demanded measures cannot be measured with these techniques.

Notes on the Hedonic Technique: A Description and Assessment

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Abstract

Key concerns of economists in valuing recreational resources are the ability to transfer information and results from one group of people to another and from one geographic area to another, the ability to aggregate results over different sets of individuals, the value of both leisure and travel time, and the use of information on individuals that is normally discarded when they do not react as one would expect. The hedonic approach estimates the demand for a good by observing the demand for the bundle of characteristics that makes up that good. This is particularly insightful as a means to valuing recreational activities which do not have formal market values.

Résumé

Les principales préoccupations des économistes dans l'évaluation des ressources récréatives concernent la capacité de communiquer les informations et les résultats d'un groupe de personnes à un autre et d'une région géographique à une autre, la capacité de réunir des résultats provenant de divers groupes de personnes, la valeur des périodes de loisirs et de déplacement, et l'utilisation de renseignements sur des personnes, qui sont habituellement éliminés lorsque ces dernières ne réagissent pas de la façon prévue. L'approche hédoniste évalue la demande d'un bien en étudiant la demande pour le groupe de caractéristiques qui constituent ce bien. Cette approche est particulièrement pénétrante comme moyen d'évaluer les activités récréatives qui n'ont pas de valeurs commerciales officielles.

A chap named Dale Poirier at the University of Toronto has recently written a paper (1984) on rationalizing the anomalous performance of models on different data sets. I think if you think about the problem you face in terms of macro theory between Keynesians and Monetarists, you are always observing the two approaches to study and the two camps which support those approaches. If you apply one model to one data set you get one result, and if the other is applied to another data set you get another result, and the question is, why should that happen? It seems to me that one of the questions I was going to raise at the end of my talk was that if you apply a particular technique then you want to ask yourself: "What is the marginal value of having another technique, or if looking at a particular question, which methodology do I choose?" And it seems to me that there are not enough strengths in any one methodology for it to be universally applied. So, I guess my point is that we have to test. In fact, we do now have a formal method of testing those things, and what we have to do is have a series of data sets so that we can formalize this process.

I have no strong preference, I should add, for hedonic functions. I have done some work in them and rather than do more technical work, my approach is really going to be; intuitively, what is the hedonic technique doing, and then, what are the fundamental problems and assumptions we have here? And finally, I will throw out some tidbits: what should we be thinking about here today when we are looking at these different techniques? For those of you who do know the literature, this may seem somewhat of a trivial exercise, but I think that it is important that one have an intuitive grasp as to exactly what is going on underneath all of this fancy statistical work. And certainly when one thinks about hedonic models, the term hedonic has been applied to virtually any case in which we have characteristics; so there are a general class of models that you call hedonic. I have never determined whether it has anything to do with hedonism or not but that's beside the point. The hedonic model is really applied in this case here to non-traded goods. There is no market formally in which fish are bought, or sold for that matter, and what we argue is that one can match differences in the expenditures with differences in the measured rates of utilization. To give you an idea how the hedonic models were developed by Griliches in the early 70's, the following observation can be made. If you went out to a car dealership and you observed someone buying a green Chevrolet, then you observed someone else buying a silver metallic Chevrolet, a virtually identical car except for the colour, then presumably one could infer that the marginal value of that difference in colour was reflected in the difference in cost between the two cars. And indeed that is true; if you do go to a car dealership and try to order silver metallic, you do pay a premium. Part of it is cost, but I'm sure part of it is reflected in the fact that people are going to pay a little bit more for it.

In principle, therefore, you can establish the value of characteristics or of a single characteristic by assuming individuals are alike in their tastes or their incomes and possess a certain technology but they face somewhat different prices. In the case of the fishing, they are in fact at different distances from a particular site so they have different expenditures. Individuals can select a level of quality of the recreational fishery by selecting among different sites. Where choices are possible, information on the demand for fishing quality is imbedded in the observed expenditure pattern. This demand is generally determined in a two-step fashion. First, we determine the implicit price of the non-traded good or characteristic and then secondly we use that information, that implicit price in order to derive the demand function. Now the hedonic method provides estimates of implicit prices of these characteristics, where sites are differentiated not necessarily by types of characteristics but rather by the amount of each characteristic, although it would presumably handle both. And therefore again, in principle there are enough sites

to form a continuum of combinations of characteristics; then it is possible to estimate this implicit price relationship which gives us our expenditure to or at a site as a function of these site characteristics.

We obtain the demand from the expenditure function, having observed this set of characteristics, having used that information to derive our implicit price. One can again in principle obtain the demand for that particular characteristic by making some assumptions, on the utility function, in particular separability assumptions which make the marginal rate of substitution between characteristics independent. Without the separability assumptions, the demand for characteristics would require some additional price and quantity data.

The theory which underlies the hedonic approach people attribute to Rosen (1974), although individuals prior to Rosen had talked about it but had not formalized it in that way. Without drawing a lot of pictures, effectively what Rosen says is that what we are looking at is really an underlying market of characteristics rather than markets for goods. So that again, if you think of our car example, people don't demand cars, they demand characteristics bundled in a certain way, and if you rebundle the characteristics, then you get a different car. So you can take horsepower, fuel economy, comfort, and colour, for example, and if you bundle them in a certain way, then you get a BMW and if you bundle them in another way, you get a Volkswagen. That's the nice thing about the hedonic technique: by observing how expenditures vary with the rebundling then you can presumably infer what the value of those characteristics is. So what Rosen is saying is that on the supply side we have individuals converting goods at certain prices into characteristics, and that there is cost minimization for individuals which generates the supply function for a characteristic. Then we have utility maximization, which gives us the result. Given the resulting cost function and some budget constraints, it permits the derivation of the demand curve for each characteristic. And then we have a demand–supply interaction which provides an equilibrium price and quantity. As we know, economists always work in equilibrium and data is always collected when the world is in equilibrium. So that in turn reveals our total expenditures for the characteristic. And then variations in the goods, prices and incomes produce a total expenditure function over all characteristics and the derivative of this expenditure function with respect to the characteristic, R or J or K, yields the price. Empirically, however, we don't follow that set-up. Empirically we start out with the expenditure function, we find the price of characteristics and we use that to estimate the demand function for the characteristics; there is a very broad literature on this. I think that one of the better illustrations of the application of the hedonic approach is contained in work by Harrison and Rubinfeld (1978).

We can look at a number of different cases. If all individuals have identical utility functions and incomes, they will have identical demand functions for a characteristic and the derived implicit price will in fact be the inverse demand function since it represents a point on each individual's demand function. Given identical demand functions, all observations of this price will lie on this same demand function for all individuals.

$$\text{Exp} = E = f(C_{11}, \ldots C_{1N}, S_{11}, \ldots S_{1N})$$

$$\frac{dE}{dS_{11}} = \hat{P}_{s_{11}}$$

Case two: if the supplies of sites with different bundles of the same characteristics is perfectly elastic, the implicit price is exogenous, so that the ordinary demand function can be identified by relating observed quantities of the characteristic with the implicit prices. So in this case, you would regress the dependent variable quantities of characteristics on the implicit prices plus other variables.

$$S_i = f(\hat{P}_{s_{ii}}, X)$$

Case three would be if the number of sites is fixed and each site has different proportions of the same characteristics, including the characteristics of interest, which in our case would be fishing quality. Then what we would end up doing is regressing the implicit price on the characteristic and other socioeconomic characteristics. So in this case the implicit price is the dependent variable.

$$\hat{P}_{s_i} = g(S_i, X)$$

Case four is that if you had sufficient information you could specify both the demand and supply side and estimate it simultaneously. So in principle, the hedonic technique does handle demand and supply. There are very few studies that have in fact specified the supply side. The implicit assumption is that the supply is exogenous and in fact completely inelastic.

Briefly, the problems or assumptions with the hedonic technique would be the following, plus probably some more I've forgotten. First of all, it assumes that the characteristic market or site market is always in equilibrium, so that you have this series of equilibrium demands and supplies. Therefore, in fact, the implicit price does in fact measure that point at which the marginal bids for the characteristic are exactly equal to the marginal offers or cost for the characteristic. That kind of assumption requires certainly perfect mobility between sites: no discontinuities on the supply side and no transaction costs on the demand side. However, having chatted with Clive Southey, I think that that may in fact be able to be handled; I think he is going to talk a bit about nonconvexities, so I'll leave that to him.

The second point is that this equilibrium implies that there is complete and instantaneous market adjustment, and I think this really goes back to many of the comments that have been made or alluded to earlier that when people lose something, when can you repackage? If you can't repackage, then you will get one result; if you can repackage instantaneously, then you will get presumably another result. Economic agents must also have full information on characteristics. To refer again to a comment that was made earlier, if people do not have the same information base, then in fact there may be differences between what the real prices are and what the perceived prices are.

The second major assumption behind the hedonic model is the way, empirically at least, the supply side is treated, and that is the completely inelastic supply of sites. In a sense, what this does is, if individuals vote with their feet (and that's really what the hedonic method is all about, observing how people bid and incur expenditures for different bundles of goods at each site), then in fact we can estimate the marginal prices; that is, we do not have the identification problem because we have assumed it away in a sense.

Let me move on to points that I was going to make, and these are questions that I throw out. It seems to me, in the debate with respect to the hedonic technique or Talhelm or

contingency valuation, that one point that cannot be ignored is, what are the strengths of these techniques with respect to what I term their "transferability"? In transferability I refer to both users and areas. That is, if we obtain a number through whatever technique, how applicable is that number derived from central Ontario to northern Ontario, to eastern Ontario, to Nova Scotia and Quebec? There is literature in the transportation area which addresses that problem, that is, what are the conditions under which a number or model can be transferred from one area to another? A second point, and it's one that has been addressed in the literature, is, how transferable are models over uses? If the hedonic technique really does measure voting with one's feet, then presumably it is applicable to users, but what about non-users, what about people who simply like the fact the fishery is there? Clearly, in that case, I think that there is a reason for having a menu of models because we in fact may want to look at different uses, or over different areas.

The second issue is aggregation. It seems to me that if we are estimating this model on observed behaviour, we want to insure that the underlying nature of the preferences we've either assumed or imposed on our model are consistent with aggregating it over different sets of individuals.

Thirdly, and this issue is again addressed in the literature somewhat, is the question of value of time. This issue I think goes back to problems within the contingent valuation method and also problems within the hedonic method. It was alluded to a bit earlier, that we know people's value of time is both a value in use and value in exchange, and we generally argue that the value of exchange is the wage rate, the opportunity cost. But in fact, if we observe people making choices, you spend an hour fishing or you spend an hour cleaning the latrine at your cottage; we know that people prefer one and not the other, and yet their opportunity cost is exactly the same. Therefore, it doesn't make any sense that you should use the wage rate to value time. What you need to somehow capture is that marginal value of time in use, the marginal utility of time, and empirically I'm not sure how one handles that. Exactly the same problem arises in transportation studies.

Finally, there is a set of models that has been used; I've seen one example of it, a paper by Morey (1981), who looks at the demand for individual sites, that I think could be used in the literature to compare many of the approaches. This is the quantal choice model literature when you look at people's choices among a discrete set of alternatives. It involves logit analysis and probit analysis, and discriminative function analysis, as a matter of fact, is one of the classes. This type of approach can be used to look at discrete choices, why people choose site A rather than site B, but it can also be used to look at why people choose site A over a number of different sites. The fundamental issue I think one has to keep in mind is that we only observe what people do, we never observe what they don't do. And economists have traditionally thrown that information away, whereas psychologists have not. The fact that somebody doesn't do something is important, and what this quantal choice literature does is to take that information that we traditionally throw away and use it to determine how people value the characteristics of a choice or the choice itself.

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Valuation of Benefits Generated by the Sport Fishery: Some Comments

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Abstract

At times, in the field of economic research, researchers seem to be obsessed with the quest for the best-fitting regression. However, they should not lose sight of the fact that the functional form selected should have its foundations in the theory of consumer behaviour. Empiricists must ensure that the form reflects the preference ordering consistent with the axioms of consumer theory. However, the economists' intuition of these preferences is limited and flexible functional forms should be used.

Résumé

À certains moments, dans le domaine des études économiques, les chercheurs semblent être obsédés par une recherche de la régression la mieux ajustée. Cependant, ils ne doivent pas oublier le fait que la forme fonctionnelle choisie devrait être basée sur la théorie du comportement du consommateur. Les empiristes doivent s'assurer que la forme reflète l'ordre de préférence compatible avec les axiomes de la théorie du consommateur. Cependant, l'intuition des économistes concernant ces préférences est limitée et des formes fonctionnelles flexibles doivent être utilisées.

I would like briefly to rephrase what Dr. Gillen has said about hedonic pricing, and then bring up another point that he didn't mention. My work with the Department of Fisheries and Oceans focuses on the valuation of benefits generated by the sport fishery. To the extent that acid rain affects the quality of the fishing experience, the resulting impact on benefits accruing to the angler can be estimated. The most basic problem in estimating benefits in this case is that there is little market information available that characterizes the behaviour of anglers. One method of dealing with this problem is the hedonic pricing framework. The idea here is to utilize available data on travel cost expenditure and the level of fishing characteristics found at sites to estimate the willingness to pay for each characteristic. Armed with this, we can then estimate the total benefits across characteristics.

The papers I have written have been concerned with interpreting the major issues raised in the literature for an audience not familiar with the rigours of journal-level microeconomics. As such, the comments I would like to add to these proceedings are of a general nature, aimed at those who have employing these "new" empirical methods.

At times in the field of economic research, researchers seem to be obsessed with what one might call a quest for the best-fitting regression. Rather than attack the somewhat mystical statistical techniques sometimes used, I want to focus on the issue of functional form. Specifically, the researcher must not lose sight of the fact that the functional form selected should have its foundations in the theory of consumer behaviour.

Much effort has been devoted to motivating hedonic pricing using, for example, the economic theory of household production. Analogously, the empiricist must ensure that the functional form imposed on the system reflects preference orderings consistent with the axioms of consumer theory. Failure to do so might provide a better fitting regression in the statistical sense but yields a model lacking in economic content. As such the functional form used should not impose a priori restrictions on the nature of the underlying utility function. Our intuition of the nature of these preferences, as has been demonstrated, I think, by the discussion this morning, is at best limited. This fact would seem to recommend that the use of flexible functional forms, which allow the data to determine the characteristics of the utility function, should be used.

Analysis of Willingness to Pay for Recreational Boating on Lake Ontario

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Abstract

This presentation reports on a study which uses the hedonic technique to estimate the value to boaters of specific experiences and products of recreational boating on Lake Ontario. For the underpriced intermediate product, harbour facilities, the contingency valuation approach was used. For the unpriced attributes, including relaxation and leisure, family outing, travelling, racing and others, both the contingency valuation and the hedonic valuation approaches were used. Assumptions and sources of possible error are explained as well as several possible uses for hedonic and contingency valuation for acid rain evaluation.

Résumé

Cette communication traite d'une étude effectuée au moyen de la technique hédoniste pour estimer la valeur, pour les plaisanciers, d'expériences et de produits particuliers liés à la navigation de plaisance sur le lac Ontario. Dans le cas du produit intermédiaire, soit les installations portuaires, dont le prix a été fixé très en-dessous de sa valeur, la méthode d'évaluation des éventualités a été utilisée. Dans le cas des attributs pour lesquels aucun prix n'a été fixé, y compris la relaxation et les loisirs, les sorties en famille, les voyages, les courses et autres, on a employé les approches d'évaluation hédoniste et d'estimation des éventualités. Les suppositions et les sources d'erreurs possibles sont expliquées ainsi que plusieurs utilisations possibles des évaluations hédoniste et des éventualités dans l'étude des pluies acides.

The purpose of the empirical study I've done for Fisheries and Oceans is to determine the value to boaters of specific products and experiences of recreational boating on Lake Ontario. Specifically, certain underpriced intermediate products and several unpriced attributes of recreational boating are the subjects for which estimates of consumer surplus are determined using variations on the hedonic pricing method and contingency valuation. For the intermediate product, harbour facilities, the willingness to pay (contingency valuation) approach was used. As for the unpriced attributes, both willingness to pay and the hedonic valuation approach were utilized (in this case, only to determine the hedonic ranking of attributes due to the use of ordinal as opposed to cardinal ranking). The unpriced attributes include: racing, travelling; being outdoors on the water; freedom of boating; social aspects; family outing; relaxation and leisure; and other related activities. Since the valuation techniques were used to measure marginal and not gross consumer surplus, variable cost and variable products were emphasized (as opposed to the fixed costs of the boat, for instance). Due to the nature of the marginal costs of boating, the travel cost approach was not deemed appropriate.

The variable costs included in the study are berthing and storage costs, boat maintenance, boat insurance, fuel, membership fees for yacht clubs, travel costs, and opportunity costs. And as I stated earlier, these costs were ranked ordinally (as were the unpriced attributes mentioned). The variable products included an activity-day budget for the whole boating season for the following: racing; overnight cruising; day trips; working on the boat at the harbour; socializing; and fishing. Since the contention is that boaters think of the product of boating for the whole season, activity days were seen as a good proxy for boating output.

The survey method involved a general questionnaire of 200 recreational boaters at approximately 60 harbours on Lake Ontario. Along with identifying questions, boaters were asked for characteristics of their boat, such as length, width, value, and for characteristics of their boating habits. The hedonic valuation section first asked boaters to ordinally rank their top three marginal costs; then the boaters were asked the percent increase willing to be paid for the ranked boating marginal costs. Percent willingness-to-pay was an open-ended question, mainly due to the small sample size. I acknowledge the problems mentioned earlier; however, in this survey, boaters based their willingness-to-pay response on actual costs, thereby reducing possible bias. The willingness-to-pay measure used determines percent increase willing to be paid to maintain the same level of output or activity. The two rankings were separately regressed (using first rank only, to simplify the procedure) with percent willingness to pay to determine the marginal effects of each attribute and cost on percent willingness to pay. Therefore, the result is a marginal hedonic ranking of attributes and not explicit marginal valuation of attributes.

The harbour facility valuation section asks the following for both transient and home port use (we made that distinction with the boaters): they were asked for the actual price they paid per foot, per day, for transient berthage, and per season, for homeport berthage. Then they were asked, respectively, the percent increase willing to be paid for the same level of use (they were open-ended questions, for the same reasons cited earlier).

There was a nice scatter of the actual prices boaters paid. Regressing total willingness to pay for transient harbour services on cruising overnight days (as a proxy for transient harbour output) permitted the estimation of the transient berthage compensated demand function (from which both marginal consumer surplus and elasticity can be determined). Valuations were also determined for various areas on the lakes, zonal classifications, service level classifications, ownership, income groups, boat types, and boat lengths. Analysis of home port berthage was similarly carried out.

For the hedonic ranking there definitely exist three favourite attributes that boaters select, and these are: free-

dom, being outdoors, and relaxation and leisure. As for the dominant cost, it is definitely berthing and storage, with all others far behind. This is the rationale for using marginal consumer surplus to measure marginal valuation of the hedonic ranking of unpriced attributes. As will be shown in the report, willingness to pay for the hedonic ranking is much greater than that for the harbour facilities alone. Hence it is contended that the marginal value of the unpriced attributes must lie in the marginal consumer surplus measure as well as in the marginal expenditures boaters make. Generally, the results appear to be consistent with what one would expect. Willingness to pay for transient ports is lower than that for home ports and again lower than that for the hedonic package. For instance, mean willingness to pay for the hedonic package is 98.5%; it is 60.2% for home port berthage and for transient berthage it is 57.8%.

One can infer there is more sensitivity to prices with decreases in fixity of the variable discussed. Comparing the elasticities of the various products, one can see that transient ports are more price-sensitive than are the home ports, due mainly to the fixity of the boater to home port berthage (for instance he may live or work there). Hedonic characteristics are even less sensitive to prices than home or transient port, due to fixities as well. Boaters value the hedonic boating package highly because no preferred substitute offers the same package of attributes.

The strengths and weaknesses of contingency valuation were mentioned earlier today. The willingness to pay or contingency valuation biases, the free rider problem, and the fear of possible increase in rates put downward bias on the estimate; the hypothetical nature of the question, the hope for increased investment, and, in this study, the method of sampling biased the measure upward. Specifically, the survey method which sampled boats actually in their harbour biased observations towards those boaters that own larger than average boats and boat more than the average amount. Therefore, the sample may not be representative of the whole boater population. In analysing the results, it was observed that those boaters tended to bias their willingness to pay upward. To retain the data in raw form, I assume that these biases negate each other. Another problem is, as mentioned earlier: can individuals actually estimate their marginal willingness to pay or consumer surplus? Furthermore, the assumption that marginal value of the unpriced attributes is in the consumer surplus implies that the intermediate products, such as the harbour facility, may have some value as a final product as well as being an intermediate product of the boating experience. So harbour facilities and other intermediate products may give some direct utility. As I mentioned earlier, the data derived from the hedonic ranking is ordinal and not cardinal; therefore marginal valuation cannot be determined explicitly for the unpriced attributes.

Another source of possible error may be that the data used to estimate demand curves for harbour facilities are proxies for harbour facility output; nonetheless, they did yield consistent results. The generally low level of significance of the regression results is due primarily to the small sample size, and the fact that it is a cross-section study. Strengths lie in the direct interpretation of willingness to pay as a measurement of consumer surplus. The activity-day or boating time budget is very useful as a proxy for boating output. Since the survey used the contingency evaluation method, the personal interviewing process was more appropriate than, say, a mail survey. Each of the models used is a simple model; there are no simultaneous equation systems. There is a trade-off here; I tended towards the generality or simplicity of the single equation model, avoiding problems of identification and specification.

Also, we measured marginal consumer surplus as opposed to gross consumer surplus. It was felt that marginal consumer surplus was easier for boaters to grasp (as a measure they could relate to). If one compares the two, it seems to be much easier for a boater to respond if asked how much more he would be willing to pay to maintain his same level of use, than if asked how much he would be willing to pay before discontinuing his use completely; also, it is easier to interpret economically.

There exist several possible uses for hedonic and contingency valuation for acid rain evaluation. Ordinal hedonic valuation can be used, if, for instance, one takes two lakes, one normal, the other acid (assuming all else equal), and asks boaters a very simple questionnaire detailing their activity-time budget for recreational use of those two lakes. From that one can derive an ordinal valuation that should vary with the acidity of the lakes. One can determine the total utilization rate and recreational activity mix types, assuming each varies with acidity. If one actually wanted to get some measure of dollars and cents, one could ask, once cottagers are at the lake, how much they are willing to pay, say, to fish or swim in either the acid lake or the normal lake. Collecting data on investment/expenditure at the cottage should reveal the marginal valuation of acidity on cottager's lakes.

Estimating the Values of Potential Acid Precipitation Damages to Sport Fisheries in Canada – The Talhelm Approach: Advantages and Disadvantages

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Abstract

The Talhelm method considers distinct groups of lakes which, because of their attributes, anglers regard as the same product. Behaviour responses of anglers due to changes in the quality of one or more of these lakes, due to acid rain, are examined. An angler's response could include travelling to the next closest perfect substitute resulting in increased travel costs, substituting other higher or lower priced products, quitting angling altogether, or else reducing the amount of angling at the higher priced fishing site in response to the price change. In each case, a change in welfare results. The travel cost approach provides estimates of these welfare changes. This paper presents the major advantages and disadvantages of the travel cost approach over other methodologies.

Résumé

La méthode de Talhelm examine des groupes distincts de lacs qui, en raison de leurs attributs, sont considérés comme un même produit par les pêcheurs à la ligne. Les réactions des pêcheurs aux changements dans la qualité d'un ou de plusieurs de ces lacs, en raison des pluies acides, sont analysées. La réaction d'un pêcheur peut se traduire par le déplacement vers un substitut présentant la deuxième meilleure qualité, ce qui entraîne des coûts de voyage accrus, le remplacement par d'autres produits de coût supérieur ou inférieur, l'abandon définitif de la pêche à la ligne ou la réduction de cette activité pratiquée en un site plus coûteux par suite du changement de prix. Dans chaque cas, le résultat est une modification du bien-être. L'approche du coût de déplacement fournit des estimations de ces modifications du bien-être. Le présent document indique les principaux avantages et désavantages de l'approche du coût de déplacement comparativement à d'autres méthodes.

I want to make a comment about this "willingness to pay" and "willingness to accept" difference first, before we get into my paper. I haven't really thought about this very much, but in comparing willingness to pay and willingness to accept, willingness to accept applies to people who already have ownership of something. The question is, how much would you be willing to accept to give up ownership of another unit of that thing? Anytime there is a purchaser of some thing, there is also a seller of that same thing, and the purchaser is bidding away from the seller. So, in the market place we observe a price-quantity point at which the seller and the demander are transferring ownership. Now if one asked everybody the price at which they are willing to sell, one could describe a supply function. Then if one asks everybody how much they are willing to pay to buy something, one can describe a demand function. Now, in experiments on contingent valuation, we ask people how much they are willing to pay and how much they are willing to accept, and in fact we would expect one result to describe a supply function, the other one to describe a demand function.

In one very recent experiment for example, Bishop (1984), studied trophy deer hunting permits in Wisconsin. He asked those who drew permits in a random drawing how much they would be willing to sell their permit for, and people who did not get permits, how much they would be willing to pay to get them. It was not entirely a hypothetical problem, because he said that the lowest four prices that people would be willing to accept would actually be purchased at the price that they offered; so they had better not offer too low a price, otherwise it would get taken away from them. And the highest four demanding prices would be used to purchase those four permits, so that they had better not bid too high, otherwise they would going to have to actually pay it. They actually transferred four permits. There were very few people willing to sell for a low price. One simply arrays those in the order in which one finds them, ie., how many permits will be forthcoming at each price in the market place, to obtain a supply curve. There were some million-dollar prices and he threw those out, but he included some in the $10,000 and above range, making the average willingness to accept $1,200 per permit. The average willingness to pay was only $23.00. And of those that actually were sold, one case was an individual who broke his leg before the hunting season, so he offered a low price and his permit was sold; there were a couple of other cases similar to that. But those were sold at the market price and at that transaction, the willingness to pay and the willingness to accept were equal. If we add the bids over the entire supply curve, we are likely to get some very high numbers. Similarly, the demand curve would give us lower numbers easily. I suspected that that has a lot to do with what we are observing in these differences between willingness to pay and willingness to accept, so we have to be a little more careful about how we compare those, and whether we are really comparing the same change in quantity or not.

Another comment if I may, just on non-use values. We're concentrating on use values here. A point has been made by Tom Crocker very well, and others, that we are not considering non-use values. There is other literature on non-use values and almost by definition, contingent valuation is the only way you can get at establishing a real market value.

Getting to the travel cost approach, I interpreted my assignment as simply to list the advantages and disadvantages of the approach, because the Victor and Burrell study

(1982), which Peter Victor is going to talk about shortly, has some theoretical information as well as a practical application of it. Basically, the approach is very much like a market analysis in which the supply is predefined. Prices are predefined and different markets have a completely different set of prices. Each origin zone has a different set of distances to the different products and therefore different prices for the different products; so when we observe two different origins, they could have an entirely different set of prices for exactly the same sites. From that we can look at how people behave: We can estimate demand functions because we have predefined supply. When I say price, what I mean is the cost of providing one's self with angling. That defines a supply in a special sense of the word, but in a very important critical sense. That defines supply from the individual's perspective. Another critical aspect is defining the products. Products are basically defined as different units of a good, different lakes for example, that are for all practical purposes the same. The same concept applies to other regular market goods defined in the market place, like different kinds of wine, different kinds of automobiles, different kinds of breakfast cereals, different kinds of music. It's not an unusual concept at all. In fact we use it for species definitions. Each individual, each human is different. We recognize that, but for biological purposes, those differences are not important when we are talking at the species level. And so we are aggregating humans and differentiating them from nonhumans, the same way we aggregate lakes into products.

Our attempt is to find those lakes that people think are basically the same product, but different from other kinds of lakes. I have developed one procedure for defining those products and it's not the only way one can do it. Therefore I don't think that we should spend a whole lot of time talking about how to define the products. There are many ways one could do that. The advantage of defining products is that we can generalize. We can say that if a site is destroyed, completely, by acid rain or by any other cause, then some people may have to travel farther to reach an identical unit of that product. This price of the next closest perfect substitute is higher because the angler has to travel farther. Price will not increase if that substitute is closer, than the destroyed site, so only some people will be affected. That can be modeled in terms of an increase in the costs of that kind of fishing for those people. The angler's response will be to look at substitutes and decide whether to pay a higher price, whether to accept a substitute at a lower price or any other price, or whether to quit going, or reduce the amount of use in response to that price change. That is a very specific way of looking at the choices available to anglers and estimating the welfare change. I think that is a big advantage of this approach.

I would like to talk more about some of the advantages and disadvantages. The best approach is one which requires fewer assumptions, or at least assumptions that we are more familiar with in neoclassical economic theory of demand and supply. It doesn't require the assumption of the hedonic approach that one can put together attributes in any fashion and build your own product. I don't have a good listing of those assumptions off-hand, but it seems obvious to me, I may be mistaken, that the assumptions are more straightforward with this approach than with the hedonic approach and they are different than with the contingent valuation approach.

One advantages is that the approach analyzes the entire system of angling sites and the user distributions, carefully specifying individual roles of various components of the system. The hedonic approach may be applied to as few as two origins. It depends on how it is applied, whether it also utilizes that similar kind of systems analysis.

Another point is that value changes are highly specific. The value of a change in angling quality depends on what product it is and the demand for that product. It depends on the change in supply that that implies for the angler. As I said, some anglers may be unaffected by the fact that a lake is lost in the system because it's redundant; there are other lakes that are perfect substitutes that are closer. There are more apples in the same barrel, but they are higher priced, so one chooses the lowest priced apple if one thinks they are identical. So the change in value depends on how much farther one might have to travel; or if a product becomes more available, less expensive, change in value depends on how much of a savings there is to the individual. It also depends on the availability of substitutes; for example, if I prefer angling where only artificial flies can be used, another substitute might be to angle at a site in which normal regulations apply (where one can use bait or any other standard type of gear). Other individuals may prefer snagging. (We have salmon snagging in Michigan that the Department of Natural Resources really regrets having ever gotten into, but that is an alternative still. They are trying to get rid of it.) If "flies only" fishing is too costly to me, I may decide to go to another kind of fishing. Or I may decide to choose some of each because I like some of each, and that's not inconsistent with the utility function, I don't think. So we are very highly specific. There is no reason to expect that a change in catch per unit of effort of, say, 50% has a uniform fixed dollar value; it depends on where that change takes place, what substitutes are available to the people, both perfect substitutes and imperfect substitutes, and where the specific substitutes are. I think that a lot of energy has been wasted trying to find "the" value. It's like finding the value of an angler day, that's even more variable.

Another advantage is that we can evaluate a wide variety of fisheries and management scenarios; multiple changes and multiple attributes can be evaluated all at the same time. I'm not sure how the hedonic approach works, because it does one attribute at a time. And if you are changing two attributes at the same time, which do you evaluate first? I don't think that has been carefully spelled out, or maybe it's that I just don't understand it very well.

Number five, all travel cost approaches are based on observations of user behavior, not hypothetical questions. That's been brought up earlier.

Number six, the model is based on fewer analytical assumptions. If it's a simpler analysis, I think that it has an advantage there. I stand to be corrected.

Number seven, the model takes advantage of the variety found in the system for different products and for different prices. We have an advantage in analyzing prices and demand that most market econometric studies do not, because we have a wider range of prices across which we can observe. Normal market studies might not observe a wide range in price changes. So actually I think there is an advantage in estimating demand. Similarly, in my eighth point, we can simultaneously consider a variety of products available to the angler at the same time, simultaneous demands. Anglers

may exercise choice among the varieties that are available at the same time. I think it's a fairly straight forward way of handling that. Number nine, it allows for a variety of angler preferences, because even the same angler might choose different kinds of angling at different times during the season or from one week to the next, or even the next day, just because the angler likes both types. I think the hedonic approach assumes more linearity in one's preferences. For example, the hedonic assumes everyone prefers one type of regulations over the others. There are some things that I don't think can be arrayed in a linear way, like lake size or stream size, fish species. Different people just have different preferences. I found that in analyzing the demand for "flies only" angling, the demand curve is less elastic, steeper, in that anglers that prefer flies only angling are willing to pay higher prices for that angling, without taking a substitute. Those who prefer angling with bait and other kinds of lures are more willing to substitute between sites and are less dedicated to a specific kind of angling.

Now, some of the disadvantages of the method. This approach creates discrete classes of angling quality, which is the usual approach in econometric analysis. The hedonic approach is fairly new, and whether that's an advantage or disadvantage I'm not really sure because any economic analyses, in fact most scientific studies, use some kind of classification system; in biology the species are used, in chemistry other classification systems are used, such as valences. We are constantly generalizing, and I think the ability to generalize is important. The hedonic approach generalizes in a slightly different way than this approach does; each may have its advantages. The product approach neglects minor quality factors; things that are important only to a few anglers may be neglected in defining angling quality, whereas they generally could probably be included in the hedonic approach.

The approach may also be more analytically demanding, because we have to analyze a whole system. The hedonic approach could be used in a smaller market comprised of anglers from few origins. In my method one must estimate a system of equations. That's a disadvantage in the sense that one must collect more information; it's an advantage in the sense that one is able then to develop a more realistic model, I think, of the actual behaviour process of choice. I don't think, however, these last two are really significant disadvantages, because the two method would use the same data set eventually. I think it is important to estimate the hedonic approach across different markets, and that presents a different set of problems than this approach across different markets.

Number five, the costs in the travel cost and the hedonic approaches are difficult to specify exactly, the value of time, for example. Several people have mentioned this. Number six, the travel cost and hedonic approaches require intensive analyses of given geographic areas, whereas the contingent valuation approach can be used less intensively over a wider area. Therefore, I think, if we want to do a national analysis, it would be less expensive to use a contingent valuation on a national basis and then verify with the travel cost method. Maybe "verify" is not a good choice of word, but we could compare nationwide contingent estimates to actual observed behaviour in some specific markets, so we could make inferences, if we wished, across the whole nation.

There are a couple of other points; number seven, only user values can be estimated with this approach. It doesn't estimate existence value and option value. Number eight, the estimates of consumer surplus are not income-compensated willingness to pay or willingness to accept; but I think the differences are likely to be small relative to the estimation error, between compensated demand functions and non-compensated demand functions. I'm sure there are other advantages and disadvantages that I have left out, but this is a starter.

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An Economic Assessment of Acid Rain Impacts on Sport Fishing in the Haliburton/Muskoka Region: Problems of Implementation and Interpretation

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Abstract

This paper provides a general overview of a study done by Victor and Burrell Research Consulting. The study was completed in 1982 on behalf of the Department of Fisheries and Oceans to examine the Muskoka/Haliburton regional sport fishery utilizing the Talhelm travel cost methodology.

Two types of data were collected and analyzed: (1) estimates of the amount of fishing done by anglers from each of 15 zones of origin in Ontario at the 232 destination fishing sites examined in the study, and (2) data used to estimate the cost of an angler day for anglers from each origin going to each destination. Initially, fishing sites were examined on the basis of lake area, island shoreline, morphoedaphic index, types of fish species, mean depth of the lake, secchi disk reading of the lake and the watershed area. After testing to determine those characteristics most important to anglers, nine product types were defined based on lake area and morphoedaphic index.

From these data and assumptions, demand and supply equations were derived for sport fishing in the Haliburton/Muskoka region. The value of consumer surplus for that fishery was then determined as well as estimates of the impacts from further losses due to acid rain.

The study was not intended to produce definitive estimates of damages, but rather to examine how the travel cost methodology could be implemented in acid rain evaluation problems.

Résumé

Le présent document offre un aperçu général d'une étude effectuée par Victor and Burrell Research Consulting. L'étude, terminée en 1982, et réalisée à la demande du ministère des Pêches et des Océans, avait pour objectif l'examen de la pêche sportive dans la région de Muskoka–Haliburton à l'aide de la méthode de Talhelm des coûts de déplacement.

Des données de deux types ont été recueillies et analysées : 1) des estimations de l'importance de la pêche pratiquée par des pêcheurs originaires de 15 zones de l'Ontario à 232 lieux de pêche examinés au cours de l'étude, et 2) des données utilisées pour évaluer le coût d'une journée de pêche à la ligne pour les pêcheurs de chaque zone, qui se rendent à chaque destination. Initialement, les lieux de pêche ont été examinés sur la base des secteurs lacustres, des rivages d'îles, de l'indice morphoédaphique, des types d'espèces de poissons, de la profondeur moyenne du lac, de la transparence des eaux lacustres et du bassin versant mesurée par le disque de Secchi. Après la réalisation d'essais en vue de déterminer les caractéristiques les plus importantes pour les pêcheurs à la ligne, neuf types de produits ont été définis d'après la zone lacustre et l'indice morphoédaphique.

À partir de ces données et hypothèses, des équations de demande et d'offre ont été déduites pour la pêche sportive dans la région de Muskoka–Haliburton. La valeur du surplus du consommateur pour ce type de pêche a ensuite été déterminée et les estimations des effets de pertes additionnelles causées par les pluies acides ont été établies.

L'étude ne visait pas à produire des estimations définitives des dommages, mais plutôt à examiner comment la méthode par le coût de déplacement pouvait être mise en application pour résoudre les problèmes d'évaluation des pluies acides.

Very briefly, by way of background, we did a review of methods for valuing the effects of acid rain on Canada's fisheries back in 1981, in which we tried to look at all kinds of fishing activities, not just angling. In the course of that survey, we identified Dan Talhelm's work as offering a promising approach to analyzing the effects of acid rain and the value of those effects on sport fishing. On the basis of that, we then proceeded to have a closer look at that methodology for DFO. Our terms of reference were not so much to produce definitive estimates of damages, but to give everybody a better idea of what is actually involved in implementing this methodology and to try to see whether it really was feasible.

As a result of this, I wouldn't want to put very much weight on the quantitative estimates that we generated, and I'm not going to talk to you about those today. I'm just going to explain very briefly what we did to implement Dan's methodology and then to conclude with a few comments on some principal ways for improving the implementation of the methodology, should a decision be made to proceed with it.

The area that we focused on for considering the effects of acid rain was the Haliburton–Muskoka region, and for the purposes of the study we identified 232 major destinations, i.e. individual lakes that anglers go to in the region. We identified, in addition to that, the origins of the different anglers. You can in Fig. 1 see how we divided the province up into these 14 or 15 areas, identified a particular node within each area and made the simplifying assumption that everybody, say, travelling from zone one or origin one to the Muskoka–Haliburton region actually lived at Chatham, and the same for all the others.

We had to do two things, in terms of collecting data; firstly, we had to get estimates of the amount of fishing done by people from each origin at each of the 232 destinations. The second thing we had to do was to estimate the cost of an angler day for people coming from each area of origin to each of the destinations. We used various information sources available to make those estimates, and one has to recognise the inaccuracies in our estimates, because the data sources we

FIG 1. The Province of Ontario — counties, districts, regional and district municipalities.

used were not originally designed to be used necessarily in this way. However, the key point is to recognise the fundamental information that is required: the number of visits from each origin to each destination and the cost per trip.

The second major component of the study was to identify the products. I should say that one of the reasons why we were initially attracted to this methodology was because of this concept of a fishing "product". It turned out that in discussion between economists and non-economists, once the economists started saying things like "We think there are certain kinds of fishing activity that can be distinguished and are in fact distinguished by anglers," they say "Yes, that's correct." It can depend upon the likelihood of catch, it can depend upon the type of lake, but basically there are some characteristics which, in combination, can be used to define different kinds of fishing activity. So, as I say, we were attracted to this method, because any time the concepts allow economists to talk to the others and vice versa, you have to consider that a plus.

In terms of application, we had information for each of the following characteristics for each of the 232 lakes in the system: lake area; the shoreline of the islands, if there were any in the lakes; the morphoedaphic index, which is a measure of productivity of the lake; the type of fish species in the lake; the mean depth of the lake; the secchi disk reading for the lake, and the watershed area. We then introduced these scores. For example, for lake area, we said "Let us divide all lakes into one of three categories of size," and so on for all of the other characteristics. Then we said, "Let us suppose that the characteristics that really matter to anglers are not necessarily this whole list, but maybe just lake area and fish species, for example." Well, if we just take these two characteristics and we have a possibility of three scores for each, we have in a sense nine types of fishing product. For example, one fishing product would be a small lake with the first type or first grouping of fish species.

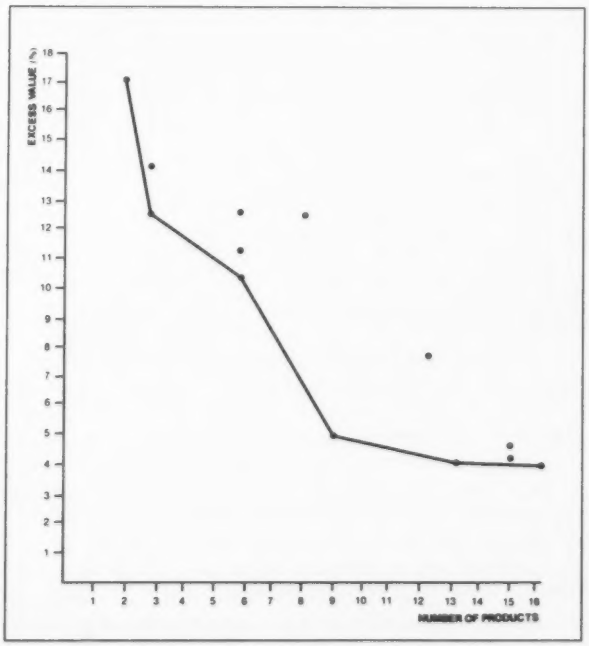

FIG. 2. Number of products and excess value.

But it was a hypothesis; we couldn't be sure that anglers really believed those were the important characteristics. So we tried to test for that, which we did in the following way. We said, "Given a hypothesis of that sort, that only those two characteristics matter, giving us nine potential products, if anglers from a particular origin agree that our product classification is also their product classification, they will generally go to the closest lake to them for any specific product." Why travel an extra fifty miles to a lake which in principle offers you the same kind of fishing if there is another fifty miles closer? We therefore looked up the observed travel behaviour in combination with a hypothesis about the products and performed the following kind of analysis. Each of the points in Fig. 2 represents a different hypothesis for the product classification. For example, here's a point here, where we are only talking about two products. That says, for example, let us assume that the only thing that matters to people is the watershed area, as a sort of proxy for the scenic features of the lake.

Well, it turns out that when we looked at the travel behaviour, we observed that people were spending a lot of money to go to lakes further than they would have to if the only thing that mattered to them was the watershed area. So we get this measure of excess value, excess travel. As we tried different product classifications, we found that when we came down to this particular classification with nine products, and that, incidently, was lake area and morphoedaphic index, the extra expenditure by people to travel to lakes other than the one that was closest to them for that product was relatively low, and that enlarging the number of products didn't push that extra expenditure down very much. So, of course, we still have some people paying attention, as Dan Talhelm said, to other characteristics, but we felt that this suggested that these two characteristics alone were consistent with people's travel behaviour, and gave us a good set of products to work with; not, and I think this is important, not a set of product definitions that we are imposing on the angler, but one that we are arriving at through a review of angler behaviour.

Having gone through that stage, we now had our nine products; we had two hundred and thirty-two lakes; we were able then to say which lake provided which product. Therefore, from any origin, we would have information on the frequency of visits to the various lakes that provided specific products, we would have the cost of the visit. We made assumptions on the supply side, that the supply of fishing at any lake was perfectly elastic. In other words, any angler could keep returning to the same lake for the same price as many times as he liked, and he would always find the same fishing quality there when he arrived. That assumption allowed us to identify the demand curve, the demand equation which we then estimated, so we then had everything we needed for the final implementation of the method. We had estimates of the demand equations, we had estimates of the supply equations; we knew for every origin the cheapest source of supply of each product, and we could then complete the analysis.

What I will show you now is completely hypothetical, but it is illustrative of what we actually did then. This is the estimated demand function; we didn't use a linear formulation, but just for an example this will do. Figure 3 shows a demand function for a particular origin, for a particular product: product one. People of that origin have to pay $60.00 a day to get that particular product. People at the same

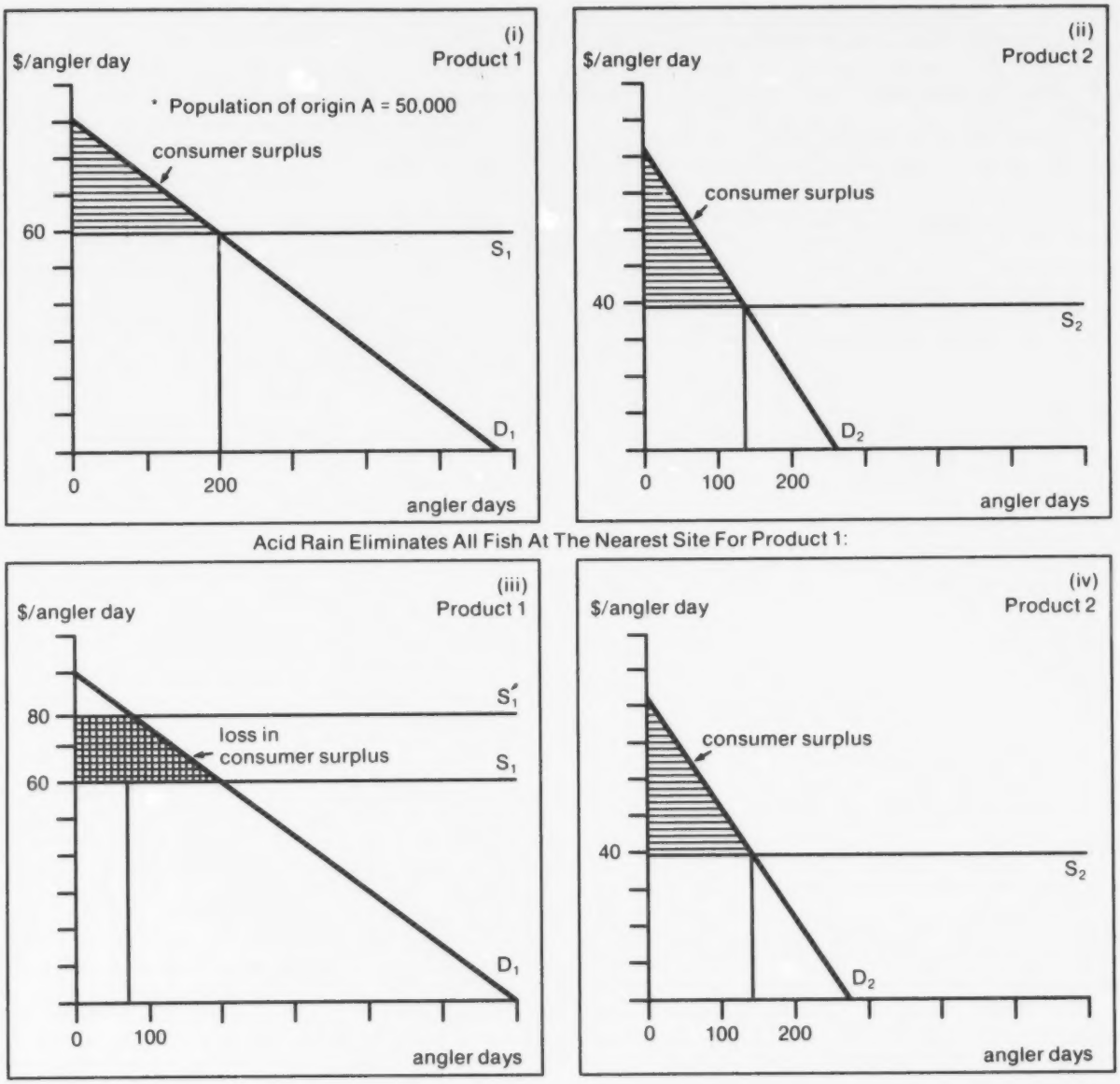

FIG. 3. Demand and supply analysis of sport fishing.

origin can get product two for $40.00 a day; in other words, there is a closer lake that provides the kind of fishing experience defined as product two, and here is the estimated demand curve. The shaded area indicates consumer surplus. Along comes acid rain. Let us assume that its effect is to eliminate the closest lake that provides product one to people at origin A. We model that by then saying that there is a lake further away from origin A that provides the same product as the lake that has just been eliminated. The shaded area gives us the loss in consumer surplus, which is the estimate of willingness to pay, willingness to accept, or the qualifications that we've heard this morning of the effects of acid rain in this system. This is, in rather simple summary terms, what it took to implement the methodology in this particular case.

What did we learn about this method that would be useful for any subsequent application? First of all, we want to get a better or more accurate estimate of the cost of angling from the origin to the destination. One way we can do this is to have more origins. In other words, instead of assuming that everbody comes from a very large area, all paying the same price, if we break that into two points of origin, then we can be more specific in terms of the actual costs paid by the various people to go fishing.

Secondly, it will help to distinguish anglers by the purpose of the trip. Somebody who makes the journey exclusively for the purpose of going fishing is incurring all of the travel costs for that purpose. Somebody else who is fishing really as an incidental aspect of their trip, and is really doing the trip for another purpose, really can't be said to be incurring the same cost for fishing for that trip as the first person. So, we wish to attack that by distinguishing anglers by the purpose of the trip. Also, we want to improve the estimates of fishing

activity. As I said, we didn't collect any data for this task in the earlier study. It seems to me that the only way to do this is to actually survey anglers to get the information from them as to where they went fishing, so that we can have a better estimate of use.

With regard to product classification, one of the characteristics notable by its absence in our list was catch per unit effort. The reason why it was absent is because that information was not available from the standard sources for each of the lakes. We would like to think that in any future work, that would be used as one of the characteristics and we would be able to estimate that.

Fourthly, I think that there is more work to be done on the specification of the demand function. I think we should look at the implications of using different functional forms. I think it's well known that the functional form can have a very significant bearing on the estimate of consumer surplus that one finally arrives at. Secondly, I think we want to include the prices of substitutes outside of the region where people are going fishing.

Fifthly, and this is a point that I think I've been provoked to include through conversations with Clive Southey, both at this workshop and at our earlier workshop, I think we need to treat explicitly interactions between fishing effort at a lake and the catch per unit of effort at the lake. It's not at all clear in my mind as I stand here what the best way of bringing that into the approach is. Dan and I have talked about this. We do have some strategies, but I would think that in any future work, that is something that would require specific thought and attention. That's a very quick summary of what we did, the lessons that we learned. I would say in conclusion that if we believe that market analysis can be useful for estimating use value, and we want to estimate use value, then I think that what Dan is offering is a practical, implementable approach for achieving just that.

Basic Principles in Planning Surveys

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Abstract

This paper presents a checklist approach to basic principles in survey design. Providing sufficient time, stating objectives, establishing end use and reviewing previous related work provide some of the groundwork that is necessary for the development of research specifications, principally in that they help to define the framework for the kinds of analysis to be undertaken. Considerations of scope, size, and budget are essential elements in planning survey research. These factors are particularly important in a situation in which the logistics of sampling respondents such as anglers present major practical problems and where those involved in the research community face the challenge of developing useful measures of behaviour and intention.

Résumé

Le présent document fournit une approche par liste de contrôle des principes fondamentaux de la conception des enquêtes. L'utilisation d'une période suffisante, l'établissement des objectifs et de l'utilisation finale ainsi que l'examen des travaux connexes antérieurs constituent une partie du travail de base nécessaire pour l'élaboration des caractéristiques de recherche, surtout en ce sens qu'elles aident à définir la structure pour les types d'analyses à entreprendre. Les considérations de champ d'application, de taille et de budget sont des éléments essentiels dans la planification de la recherche sur les enquêtes. Ces facteurs sont particulièrement importants dans une situation où la logistique de l'échantillonnage des répondants comme les pêcheurs à la ligne présente des problèmes pratiques majeurs et où ceux qui appartiennent à la collectivité des chercheurs doivent relever le défi consistant à élaborer des mesures utiles de comportement et d'intention.

Originally it was suggested that I might talk to you today specifically about the sampling problems involved in conducting surveys with anglers. And at first glance, this seemed to be a relatively easy task. But addressing this gathering on that particular topic would, I felt, be difficult. One either runs the risk of lulling one's colleagues into slumber by restating the obvious, or burdening more results-oriented participants with technical details. I was, however, assured that some latitude would be allowed within the much broader context of data considerations and survey methodology. As practicing researchers, people like myself are involved on a day-to-day basis both in designing surveys and in executing research designs. In a sense we act in one of two functions on behalf of our clients: either as architects, when we are primarily responsible for the design function, or as builders, when we are asked to carry out a design which has been prepared by someone else. This can lead to a somewhat schizophrenic state of mind at times. So for most of what I'm going to say to you today, I'm saying "we" because the kinds of problems that I am discussing are ones that face, I think, both the people who and institutions that commission research, and those of us who are involved in supplying it.

It seemed most appropriate to talk to you today in terms of some of the basic principles that we try to put into practice when we are involved in planning surveys. As we all know, the effort invested in the design phase of the project is most likely to result in efficient use of resources during the implementation. Similarly, ill-considered and hasty decisions with respect to design are most often costly both in terms of time and money, and I think we've probably all suffered from those kinds of problems. That, when I come to think about it, is probably my first suggestion for those of you who are or who will be involved in planning research programs. Adequate lead time is an essential element in the planning process. It doesn't cost anything. And it is in that sense one of the few elements in the research process that is available to all of us. It is, unfortunately, frequently one of the missing ingredients in research requests that are generated by public sector agencies. After some time, a decade or so, of working in this area, I've come to the conclusion that it is not an inevitable byproduct of the struggle that sometimes occurs between political and bureaucratic interests. As this gathering demonstrates, it is possible to initiate a rational planning process. I can only urge those of you who are involved in setting deadlines in planning research in any part of the process to continue to make every effort to provide an opportunity for all participants in any research program, designers, suppliers and end-users, to have adequate time to do their job effectively. It's probably the best return that can be made on a research investment.

Now, if we assume that we have a longer time period than the one or two weeks which are sometimes presented to us to develop research specifications, we need to look at the kinds of questions which have to be answered before we begin to develop the specifications and the kind of end products desired from the survey. On the surface, they are fairly simple questions, and perhaps this is one of the reasons why they are frequently overlooked. If you like, you can regard this as a checklist for any set of research specifications that you yourselves may be involved in drawing up, or in reviewing. One of the most important questions obviously is, what information is required? What in fact do we want to know? That's again not always as simple as it seems, because it has to be tied in with the practical aspect of who can provide answers to the kinds of questions that we want to ask. We may be able to formulate some very elegant questions. It is another thing to do so in a fashion which allows the respondents to be able to respond. How is the information from the survey going to be used? For what purposes and by whom? Explicit answers to those kinds of questions are really necessary preconditions in designing a survey. In particular, it is sometimes valuable simply to sit and make a list of the decisions, if any, that will be made based on the results of the research. This is a very useful way of helping oneself see if it has any practical purpose within the broad context of the areas we are looking at. There could be many reasons for undertaking surveys.

Policy planning, program development, program evaluation, development of a long term data base, research which is to serve as a one step in a series of surveys. Again, it may seem fairly obvious that you know all of this when you design a set of specifications. I very seldom see one that actually contained answers to those questions when presented to a design consultant.

What happens when you are able to answer these questions? Well, primarily this serves to rationalize the design process. In working through those considerations that we've just looked at in terms of objectives and end use, it may sometimes become evident that the information required cannot be obtained through primary research. This sometimes comes as an awkward and potentially embarrassing surprise if, as occasionally happens, commitments have already been made to do a survey without assessing the feasibility of undertaking that activity. Again, I would like to emphasize the necessity of going through this process before one ever sets out a set of specifications. Those of us who are research consultants, or who are involved in a consultative capacity, can certainly help you with those questions of background, but we can't answer them for you. A research design cannot supply that component. Nor, in the absence of answers to those questions, can a research supplier function effectively as a design consultant.

Let's assume again that we have established that at least some of the information required can be obtained through means of a survey. The next point we look at is the extent to which some or all of that information may already be available elsewhere. If this is the case, there may be no need for duplication. On the other hand, in certain situations there may be a strong political need to duplicate existing work. Even if new or more current data are required, it is extremely helpful to review the reports from surveys of a similar nature. Unfortunately, such reviews may be focused solely on the methodological aspects of the survey: completion rates, representativeness of sample, and so forth. That's useful, but considerable benefit can also be derived from looking at the ways in which data from previous surveys in a specific area of interest have been used or have been found wanting.

Providing sufficient time, stating objectives, establishing end use, and reviewing previously related work provide some of the groundwork that is necessary for the development of research specifications, principally in that they help to define the framework for the kinds of analysis to be undertaken. We need also to have some measure of the scope and size of the kind of project we are going to deal with. Sample size, for example, varies in accordance with the level of precision or accuracy required. In order to be acceptable to an end user, research specifications need to make sense. I have, for example, in the past couple of weeks received a request to conduct a survey with a national sample of 1,000 people, which is to be representative for each province. That happens more frequently than any of us would like, and one is forced to the somewhat simple-minded response of having to remind people that even though the population of P.E.I. is relatively small, it really is not possible to project the answers of 15 people and make it representative.

A second rereading often of a set of specifications and the gap between what is hoped and what can be achieved is a very useful break in drawing up survey specs. One hopes that the issue of target population and the assessment of the ability of a sample population to provide the information required is looked at early in the process. There is, after all, little point in expending time and money on implementing an elaborate or an elegant (not necessarily the same thing) research design if the respondents are unable to answer the questions addressed to them or if the questions are meaningless. Here again, examples are legion. I'd ask you just to put yourself in the position of answering the following question. As an example from a real survey, not, I'm happy to add, one that we conducted, but one that's out there, "How many trips involving one or more nights away from home have you taken in the past two years? And for each such trip, what was your main purpose in undertaking that trip" Quick now, you realize the interviewer is on the phone or at your door. And again, "For each trip recalled, how much money did you spend on each of the following: accommodation, transportation..." Well, I needn't go on. I think some of you have seen the same pieces of work. The difference between what one wants and what one can get is fairly obvious in questions of that nature. It's very easy, actually relatively easy, to improve that kind of questioning by simply placing it in a framework that provides a realistic period of recall for a respondent, and beginning by asking the respondent about something reasonable, like the past month. Even there, one would have to remember that someone who travels fairly frequently is likely to encounter considerable difficulty in recalling expenditure details. Perhaps it's enough, without underscoring the point, simply to note that a desire to include a certain segment of the population in a survey or to obtain certain types of data are not in themselves sufficient reason to formulate unreasonable questions.

The final point that I think is useful for people involved in the design process to remember, and again one that is often overlooked, is the question of money. Quite simply, how much money is available to fund the research? What are the budget limitations? It doesn't need a great deal of experience to realize that the cost of any survey is going to vary in relationship to the size and scope of the project, among other factors. Information on the range of costs involved for different types of surveys is readily available, and I would urge any of you who are involved in the process to investigate this area before formulating specifications. It saves everyone a good deal of time and effort and is again a much more rational approach to the process.

Now, the points I've highlighted may seem to be self-evident; it doesn't mean we can ignore them. Adequate time, clear statements of objectives and end use, review of related research, considerations of scope, size, and budget, are essential elements in planning survey research. They are, if anything, more important in a situation in which the logistics of sampling respondents such as anglers present major practical problems, and where all of us who are involved in the research community face the challenge of developing useful measures of behaviour and intention.

La pêche récréative, étude auprès de la population : réflexions et commentaires

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Résumé

Dans cette présentation, M. Pelletier traite des différentes difficultés inhérentes à la réalisation d'études auprès des pêcheurs sportifs. Dans un premier temps, le statisticien fait ressortir quelques problèmes fondamentaux reliés à ce type d'étude; soit, l'inexistence de base de sondage exhaustive, la déficience des paramètres de représentativité pour les études « sur site » et des paramètres d'analyse demandée par l'analyste (données selon la destination versus données selon l'origine des pêcheurs).

Par la suite, M. Pelletier décrit, de façon très pragmatique, les traits particuliers du pêcheur sportif québécois. Il en ressort que, en général, le pêcheur sportif est un collaborateur facile mais indiscipliné. De plus, il démontre un faible sentiment d'appartenance à son territoire ou à son activité et il est réservé sur la divulgation exacte de ses lieux de pêche et de ses niveaux de capture.

Enfin, dans un troisième temps, le statisticien présente les différentes techniques de cueillette de données selon leurs avantages et inconvénients respectifs afin d'en arriver à présenter le choix des options en fonction des besoins (mode de cueillette le plus approprié selon le sujet d'étude et le taux d'incidence).

Abstract

In this paper, J. Pelletier discusses the problems inherent in conducting surveys of sport fishermen. Several fundamental problems related to this type of study are examined: the lack of an exhaustive sampling frame, the deficiency of representativeness parameters for "on-site" studies and of analysis parameters required by analysts (data by destination versus data by origin of fishermen).

Mr. Pelletier subsequently describes, in highly practical terms, the specific characteristics of the Quebec sport fisherman. In general, the sport fisherman is a ready but undisciplined collaborator. His feeling of belonging to his territory or activity is not highly developed, and he is reserved about disclosing exactly catch levels and the location of fishing sites.

Finally, the statistician examines the respective advantages and disadvantages of the various data collection techniques in order to present the choice of options according to needs (the most appropriate collection method according to subject of study and rate of incidence).

Introduction

Le but de ce document est de présenter, de la manière la plus concise possible, les différentes difficultés inhérentes à la réalisation d'études auprès des pêcheurs sportifs. Par delà les considérations méthodologiques et statistiques propres à toutes les études, il convient d'ajouter, très souvent, des considérations empiriques basées sur l'expérience acquise dans un secteur d'activité donné. Ce sera l'essence même de mes propos d'aujourd'hui.

La majorité des personnes ici sont familières avec la pêche sportive et probablement avec les études auprès des pêcheurs sportifs. Il serait donc inutile de vous présenter les diverses méthodologies appliquées, depuis quelques années, à ce secteur d'activité. D'autre part, je ne suis pas économiste et je n'ai pas la compétence pour discuter des modèles économétriques proposés pour en arriver à la mesure de l'impact des pluies acides sur la valeur économique des pêcheries récréatives. Plusieurs modèles ont été perfectionnés, mis à l'essai et documentés par une littérature abondante.

Toutefois, depuis 10 ans, j'ai personnellement planifié et dirigé au Québec plusieurs études auprès de la population (dont plusieurs auprès des pêcheurs sportifs), notamment sur l'utilisation de la faune. J'ai été à même de constater certaines particularités de ce secteur d'activité, certaines précautions à prendre dans l'organisation d'un sondage auprès des pêcheurs, précautions qui, si elles sont ignorées, risquent d'introduire des biais suffisamment sévères pour compromettre l'utilité des résultats.

Quelques notions fondamentales

Au Québec, comme dans bien d'autres provinces canadiennes, il n'existe pas de base de sondage exhaustive permettant d'identifier d'une façon précise les pêcheurs sportifs. La liste des permis de pêche ne permet pas la création de cette base. D'une part, elle est incomplète au cours d'une même année, et d'autre part, certains problèmes légaux entourant l'émission des permis de pêche en 1983 portent à croire qu'une partie seulement des pêcheurs les ont achetés.

Cet état de fait confère aux études sur la pêche sportive l'obligation de construire la base de l'étude à partir de l'ensemble de la population, c'est-à-dire d'utiliser des échantillons de grande taille. Néanmoins ce n'est pas une situation unique. Bon nombre de secteurs d'activité comportent cette particularité. Les études sur les voyages de vacances par les touristes, les études de consommation en agro-alimentaire en sont les deux exemples les plus évidents (bière — voyage d'agrément — consommateur).

Si l'on veut prétendre inférer les résultats d'un sondage à l'ensemble de la population, il est nécessaire d'évaluer a priori la représentativité de l'échantillon. Cette mesure doit s'établir en fonction de l'origine des répondants et non de leur destination. En effet, nous ne connaissons rien des caractéristiques socio-économiques des pêcheurs selon leur destination alors qu'en fonction de l'origine, il est possible de référer aux recensements pour prélever correctement une base d'étude. En terme statistique, on ne doit pas confondre stratification a priori et stratification a posteriori.

Ceci confère aux études in situ un niveau d'utilité potentielle beaucoup plus faible qu'on ne pourrait l'imaginer. De même que l'on n'interroge pas les buveurs de bière dans un bar ou les touristes lors de la visite d'un site, on ne doit pas interroger les pêcheurs sur le lieu de pêche.

Précisons toutefois qu'en certaines occasions, des vérifications in situ peuvent être nécessaires lors de la réalisation d'une étude, mais cette manière de procéder ne sera que rarement la démarche principale.

Si l'unité de mesure de la représentativité de l'échantillon s'établit en fonction de l'origine des répondants, les paramètres d'analyse seront toujours fonction de la destination. Le produit « jour de pêche » ne peut être consommé (acheté) ailleurs que sur le lieu de pêche.

Ceci amène toujours le statisticien à effectuer une stratification a posteriori en fonction des destinations (plan d'eau, ZEC (zone d'exploitation contrôlée), zone de pêche, etc.) devant faire l'objet de l'étude. C'est ici qu'intervient également la connaissance empirique; des déplacements des pêcheurs plus spécialement en ce qui concerne la détermination de la taille de l'échantillon.

Une étude sur la pêche sportive présente au niveau conceptuel beaucoup d'analogie avec une étude de consommation dont le produit (le jour de pêche) doit être consommé sur place.

Ainsi, si l'on désire obtenir des informations relatives au degré de satisfaction des clientièles par rapport au produit ou aux services offerts, une étude sur le lieu de pêche peut être envisagée mais, si l'on recherche des indications sur les habitudes de consommation, sur l'attitude du consommateur (pêches) face à des modifications de l'environnement commercial du produit pêché, les études doivent être réalisées sur la base de l'origine des pêcheurs.

Spécificité du domaine d'étude

En dépit du fait que les études sur la pêche sportive présentent plusieurs points communs avec les études de consommation, il existe certains traits particuliers à ce secteur d'étude qu'il convient d'examiner attentivement.

Ma propre expérience dans la conduite d'études auprès de la population sur des sujets relatifs à l'utilisation de la faune et, plus spécifiquement, auprès des pêcheurs sportifs du Québec, m'amène aux constatations suivantes.

1. Le pêcheur sportif québécois est un collaborateur facile mais indiscipliné

En général, l'on peut s'attendre à des taux de réponse relativement élévés lors de la réalisation d'une étude auprès des pêcheurs sportifs, même qu'il importe de se prémunir contre la surreprésentativité des pêcheurs ayant un haut niveau d'activité.

En contrepartie, le répondant-type est indiscipliné. En mode postal, il éprouve beaucoup de difficulté à suivre les instructions aux répondants. Au téléphone et en entrevue individuelle, il a constamment tendance à se diriger vers le récit de ses aventures de pêche et à s'éloigner du sujet à l'étude. Cela exige que l'interviewer intervienne constamment pour obtenir toute l'information souhaitée.

2. Le pêcheur sportif québécois démontre, dans l'ensemble, un faible sentiment d'appartenance à son territoire ou à son activité

À l'exception d'environ 20 % des pêcheurs sportifs (surtout ceux pratiquant la pêche au saumon ou ceux pratiquant également la chasse sportive), la majorité des pêcheurs subissent avec une incompréhensible indifférence les modifications dans la qualité de pêche. Ils changeront de lieu de pêche si la qualité de leur pêche diminue au-delà du seuil acceptable, ou passeront à des activités substituts si des contraintes familiales, financières ou professionnelles deviennent plus élevées.

Bien que subjective, cette notion doit être prise en considération dans l'élaboration de modèles de mesure de la valeur de la pêche sportive. Un modèle ou une formulation trop grossière amènera une sous-évaluation de l'activité.

Nous sommes donc en présence de deux groupes d'individus identifiables par le type de relation qu'ils ont avec la faune terrestre et aquatique. Les paramètres mesurés pour chacun des groupes seront relativement homogènes mais auront tendance à présenter une grande variabilité entre eux. La littérature à ce sujet indique que, par rapport à la notion du « willingness to sell » par exemple, la variabilité des mesures passe, selon les groupes, de 3 à 20 fois la valeur des dépenses engagées dans la pratique des activités et qu'environ 50 % des observations présentent un caractère irréaliste et doivent, par conséquent, être rejetées a priori.

3. Le pêcheur sportif du Québec est, en général, réservé sur la divulgation exacte de ses lieux de pêche et de ses niveaux de capture

Une grande partie du plaisir de la pêche sportive réside dans le mystère entourant la pratique de l'activité. Les pêcheurs croient très souvent en l'efficacité de leur expérience et de leur technique de pêche pour expliquer leur succès, et en des phénomènes hors de leur contrôle tel le niveau ou la température de l'eau pour expliquer leur insuccès.

Ainsi, un lieu précis de pêche est souvent considéré comme la propriété d'un pêcheur et le contraindre à le révéler est souvent le forcer à mentir. En terme statistique, l'expérience a révélé qu'il est plus avantageux de définir des aires de pêche étant suffisamment petites aux fins d'analyse, ou d'une superficie suffisamment grande pour que le pêcheur soit à l'aise dans l'identification de sa destination.

Il en est de même pour les niveaux de récolte. Toute table de contingence trop fine (par espèce, par voyage, par lieu de pêche) force le répondant à fournir des indications dont l'erreur non échantillonale sera plus grande que l'erreur échantillonale. Il ne faut pas oublier qu'à une question hypothétique, l'on obtiendra une réponse hypothétique.

Techniques de cueillette des données : le choix des options en fonction des besoins

Sans égard à la nature des données nécessaires à une analyse économique, sociologique ou de consommation, il existe un principe général que toute entreprise ou organisme doit admettre lorsqu'il planifie une intervention par voie de sondage : « Les coûts inhérents à la cueillette de données sont inversement proportionnels aux taux d'incidence du sujet d'étude auprès de la population. » (tableau 1).

Lorsque le taux d'incidence est élevé, par exemple 70 % et plus, un seul mode de cueillette peut être envisagé. Il en est autrement toutefois lorsque le taux d'incidence est faible (30 % ou moins). Dans ces circonstances, deux modes sont

TABLEAU 1 Mode de cueillette selon le sujet d'étude et le taux d'incidence.

Sujet d'étude	Taux d'incidence	Mode de cueillette généralement priviligié
Étude auprès des propriétaires de véhicules automobiles	80 %	Entrevue téléphonique
Étude auprès de sous-groupes spécifiques (femmes enceintes, veuves, etc.)	2 – 4 %	Entrevue téléphonique suivie d'entrevue individuelle
Utilisation de divers moyens pédagogiques (éducation)	40 %	Entrevue téléphonique suivie d'un enquête postale avec rappel téléphonique
Matrices de déplacement (origine — destination) transport en commun	40 – 60 %	Entrevue téléphonique suivie d'une stratification a posteriori
Étude auprès des consommateurs de bière	55 %	Entrevue individuelle précédée d'un repérage téléphonique des ménages éligibles
Étude d'audiences et de taux de lecture	5 – 25 %	Enquête postale précédée d'un repérage téléphonique des personnes éligibles
Application possible		
Étude sur la pêche sportive	25 %	Entrevue téléphonique suivie d'une entrevue individuelle au domicile (comprenant une section auto-administrée)

Le tableau 2 suivant présente une synthèse des avantages et inconvénients statistiques de chacun des modes de cueillette des données.

TABLEAU 2 Avantages et inconvénients des modes de cueillette dans les études sur la pêche sportive.

Avantages	Inconvenients
Enquête postale	
Aucun L'enquête par la poste ne présente pas d'avantages marqués par rapport aux autres modes. Les coûts inhérents aux enquêtes postales sont souvent aussi élevés que les entrevues téléphoniques (au Québec, en 1980, il a été évalué qu'une enquête postale auprès des utilisateurs de la faune pouvait coûter 20 % plus cher qu'une étude par entrevue téléphonique sur le même sujet).	*Surestimation des niveaux d'activités* Forte corrélation entre le niveau d'intérêt et le taux de réponse. On obtient généralement une surreprésentativité des pêcheurs réguliers et une sous-représentation des pêcheurs occasionnels. *Taux de substitution élevé* Des pêcheurs non échantillonés répondent à la place de pêcheurs échantillonés. En 1979, une enquête sur la pêche auprès des femmes exclusivement a conduit à 25 % d'hommes parmi les répondants. *Indiscipline des répondants* Tableaux de contingence non conforme aux spécifications. Mauvais passages aux questions, mauvaises identifications des lieux de pêche. *Échéancier très long* À cause du nombre de rappels (au moins 2), un échéancier d'au moins 2 semaines est à prévoir.
Entrevue téléphonique	
Bon contrôle du plan de sondage Bonne supervision des entrevues et du travail des interviewers Meilleur rapport efficacité/coût Peut, selon la méthode retenue, rejoindre les non-inscrits aux annuaires téléphoniques Rapidité d'exécution Bon contrôle du répondant	Difficultés d'appréciation des données quantitatives, en raison du peu de temps à la disposition du répondant
Entrevue individuelle[1]	
Parfait contrôle du répondant Assure des données quantitatives plus rigoureuses Permet un niveau de question relativement complexe Permet de couvrir une grande variété de sujets	Coûts plus élevés Nécessite des délais plus longs que l'entrevue téléphonique

[1]Il faut distinguer l'entrevue individuelle réalisée au domicile du répondant (dont il est ici question) de l'entrevue réalisée sur la route (*road side survey*) ou dans un centre commercial, laquelle inévitablement indispose le répondant.

souvent utilisés. Un premier repérage des ménages éligibles est effectué par entrevue téléphonique, auprès d'un échantillon de grande taille. Par la suite, des rendez-vous sont fixés pour permettre la réalisation d'entrevues individuelles. Au Québec, cette technique est utilisée avec succès dans le secteur de la consommation, un secteur en général relativement difficile.

Dans le cas précis de la pêche sportive, mon point de vue, suite à plusieurs expériences, est qu'il faut privilégier l'entrevue individuelle auprès d'un sous-échantillon, construit à partir d'un sondage téléphonique préalable.

J'estime que l'enquête postale comporte trop d'inconvénients au plan statistique pour espérer obtenir des résultats convenables. L'entrevue téléphonique, d'autre part, permet d'obtenir de bonnes informations au plan général mais ne permet pas une durée d'entrevue suffisamment longue pour construire avec précision les tables de contingences requises par des analyses bio-socio-économiques.

Some Plausible Fundamental Misspecifications in Models of Preferences for Acid Deposition Control

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Abstract

Research into the acid rain question is characterized by uncertainty about the sources of precursors, about cause – effect relations, and even about the actual existence of some of the hypothesized biological and physical effects. There is some question as to whether the conventional benefit–cost approach to acid deposition control is appropriate. Two relevant issues are discussed in this paper: (1) the availability and the reliability of the natural science, pecuniary, and behavioural information that benefit–cost analysis methods require; and (2) the appropriateness of the axioms on which the conventional methods used to assess the benefits of control rest. It is suggested that the conventional model is misspecified in a number of ways when applied to the benefits of acid deposition control, and that this probably results in underestimates of control benefits. Research policymakers are advised to allow some effort to be devoted to comprehending and, if need be, correcting the forms and sources of plausible misspecification before embarking upon a "number-generating" exercise.

Résumé

La recherche sur les questions de pluies acides est caractérisée par une incertitude au sujet des sources des signes avant-coureurs, des rapports de cause à effet et même de l'existence réelle de certains effets biologiques et physiques hypothétiques. Le bien-fondé de l'approche classique avantages–coûts pour la lutte contre les dépôts acides est remis en question. Deux questions pertinentes sont traitées dans le présent document : 1) l'existence et la fiabilité des données sur les sciences naturelles ainsi que sur les aspects financiers et comportementaux, qui sont nécessaires aux méthodes d'analyse avantages–coûts et 2) la justesse des axiomes sur lesquels s'appuient les méthodes classiques utilisées pour évaluer les avantages des mesures de lutte. On laisse entendre que le modèle classique est mal caractérisé de plusieurs façons, lorsqu'il est appliqué aux avantages de la lutte contre les dépôts acides, et que ce fait entraîne probablement une sous-estimation des avantages des mesures antipollution. On recommande aux décideurs de politique sur la recherche de consacrer un certain effort à la compréhension et, au besoin, à la correction des formes et des sources de caractérisations inexactes avant d'entreprendre un exercice de « production de chiffres ».

Natural science findings on the acid rain deposition phenomenon, commonly called acid rain, are characterized by a lack of precision and perhaps accuracy. Uncertainty about the sources of precursors, about cause–effect relations, and even about the actual existence of some of the hypothesized biological and physical effects confronts the careful reader of the relevant natural science literature. In the United States, this uncertainty has been used to justify not imposing tighter controls on possible precursor emissions until "more is known." The stated view is that, given the natural science uncertainties, the economic benefits to North Americans of control may fall well short of the costs. David Stockman, the former Director of the United States Office of Management and Budget, has been quoted as saying:

> I kept reading these stories that there are 170 lakes dead in New York . . . well how much are the fish worth in these 170 lakes that account for four percent of the lake area of New York? And does it make sense to spend billions of dollars controlling emissions from sources in Ohio and elsewhere if you're talking about a very marginal volume of dollar value . . . ? (Norton 1982).

Mr. Stockman's general perspective of weighing the economic benefits of precursor control against costs strictly conforms to U.S. Federal policy. Executive Order 12291, issued by President Reagan in 1981, to replace President Carter's Executive Order 12044, requires, unless explicitly prohibited by statute, the use for regulatory decision of a technical benefit–cost analysis grounded in the formal axioms of microeconomic theory. Many highly influential writers (e.g., Leopold 1966) who deal with the natural environment vociferously reject the utilitarian philosophical basis of this perspective. Frequently these objections have a religious tone. Natural environments must be preserved because they are created by God; mankind has been granted stewardship over this creation, and is therefore obligated to protect it. Other objectives, though not explicitly religious, dismiss utilitarianism as cynically anthropocentric: it denies both our "kinship" to other life forms as well as their "rights" to strive and to thrive (Regan 1981).

Even if a consensus founded on a nonutilitarian perspective existed for valuing environmental assets, it would be of little assistance in making societal decisions. Such perspectives do not easily admit trade-offs; they tend to be absolute. What are the bounds to the rights of any particular nonhuman species? How are the rights for this species to be balanced against those of other nonhuman species? Should the utilitarian opportunity costs of human welfare simply be dismissed? If not, what role should they be allowed to play? Rarely are these issues addressed by those who assert the inadequacies of the utilitarian perspective. Other than authoritarianism, we therefore have no alternative but Mr.

Stockman's and the economist's utilitarian perspective, that values are based on, and are therefore to be derived from, individual human preferences. This is not as restrictive as it may first appear, for while it does not grant the natural environment equal status with human beings, it admits the validity of the preferences of those individuals who believe that it ought to be so granted, along with their probably extraordinarily high valuations of features of environmental assets.

Having granted the cogency of Mr. Stockman's general perspective, there remains the question of its practical implementation in the context of conventional benefit–cost analyses of acid deposition control. Two sets of issues arise. The first is the availability and the reliability of the natural science, pecuniary, and behavioral information that benefit–cost analysis methods require. In the case of acid deposition control, an insistence upon applying scientific standards of truth to benefit–cost analysis and its natural science support is easily used to justify decisions to defer controls (Crocker 1984). The economic feasibility of more stringent controls is difficult to establish empirically when control benefits appear to be subtle and distant from obvious money outlays, while compliance costs appear to be concrete with no processes intervening between control choices and money outlays. This difficulty is intensified when, in order to adopt more stringent controls, policymakers insist that marginal control benefits be "scientifically demonstrated" to be larger than control costs rather than basing decisions only on demonstrations that marginal control costs *cannot* be shown to be larger than control benefits.

The appropriateness of the axioms on which the conventional methods used to assess the benefits of control rest compose the second set of issues. Typically, these methods presume that the individual wants to acquire the rights to use certain items and to participate in certain activities. His ability to do so is limited by his wealth, the laws of society, and the physical and biological laws of nature. As applied to assessments of the benefits of acid deposition control (improvements of fresh water recreational fishing, for example), these methods proceed by observing or calculating the choices the individual makes within the set of choices that his limits allow him to make. Logical propositions derived from the axiomatic system known as welfare economics enable the assessor of benefits to connect his observations or calculations of the individual's choices to the individual's valuations (in terms of willingness to pay or willingness to accept compensation stated in units of income equivalents) of the alternatives with which nature, society, and his wealth confront him. The derived logical propositions differ from one technique to another, e.g., between travel cost methods and hedonic methods. However, the underlying axiomatic system is constant across all observed behaviour methods likely to be applied to assessments of the benefits of acid deposition control.

In the following section, we suggest that this conventional model may be misspecified in a number of ways when applied to the benefits of acid deposition control. Most of these misspecifications are likely to result in underestimates of control benefits. Our treatment here is unambitious: it is meant only to raise the possibility that some rethinking of the model of individual choice we typically apply to environmental assets in general, and acid deposition impacts in particular, might be worthwhile. We wish only to suggest that the investigator of the economic value of acid deposition impacts might very well be cheated when he buys the analytical and empirical conveniences that the conventional model offers. More critical thought must be devoted to specifying the connection between individual actions and measures of the benefits of providing and preserving environmental assets.

Some Plausible Sources of Misspecification

In Canada, considerable concern has been expressed about the impact of acid deposition upon freshwater recreational fishing opportunities. This concern is partly due to the importance of aquatic ecosystems to the Canadian tourism industry;[1] in addition, relative to terrestrial ecosystem impacts, scientific knowledge about aquatic impacts is generally thought to be more accurate and precise. Aquatic impacts are therefore obvious candidates for the application of such conventional benefit assessment techniques as travel cost methods and hedonic methods.[2]

One uses these techniques to acquire knowledge about individual preferences for the environmental amenity that is of interest. If one observes usages of the amenity across price and income settings, a demand function for the amenity can then be estimated. *Given* that certain regularity conditions are fulfilled, this knowledge of the individual's demand function is equivalent to knowing his preference ordering. If any of the regularity conditions are not fulfilled, there can be no guarantee that the preference measures generated by applications of the techniques are unique. Numerous other measures could be equally valid; one might estimate a demand function, but one cannot know what it means in terms of preferences.

The model on which each of these techniques is based starts with a vector of private commodities, $x = (x_1, \ldots x_n)$, and an environmental amenity or asset, Q. The individual obtains utility, U, from both x and Q, and he must select a particular bundle from his budget set, $B = \{x/px \leqslant M\}$, where $p = (p_1, \ldots p_n)$ is the vector of the prices of the private goods and M is the individual's "full" income; a combination of his money income and the opportunity cost of his leisure time. The level of environmental amenity, Q, varies inversely with the acidity level, A, of the aquatic ecosystem, i.e. $Q = Q(A)$, and $Q' < 0$. As in Neary and Roberts (1980) and Cornes (1980), the individual's decision problem can then be stated as:

$$(1)\quad V(p,Q(A),M) = \max \{U(x, Q(A)) \mid x \varepsilon B,\ Q(A) \text{ preassigned}\}.$$

$V(p, Q(A), M)$ is a "restricted" or "rationed" indirect utility function which depends upon prices, income, and a level of the environmental amenity (and hence acidity) over which the individual is unable to exercise any influence.

Other things being equal, increases in acidity will cause a loss in utility for the individual since:

$$(2)\quad \frac{\partial V}{\partial A} = \frac{\partial V}{\partial Q} Q' < 0.$$

The individual's marginal valuation of acidity damage is:

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[1]Leman (1982) provides an interesting commentary on the potential of the outdoor portion of this industry to serve an expanded North American market.

[2]See Freeman (1979) for a thorough review of these and other methods.

$$(3)\quad V_a(p,Q(A),M) = \frac{-\left(\frac{\partial V}{\partial Q}Q'\right)}{\left(\frac{\partial V}{\partial M}\right)}$$

This is the individual's compensating variation in income, ∂M, with respect to a one unit change in acidity, ∂A. Of interest is the way in which this compensating variation changes when acidity changes.

$$(4)\quad \frac{\partial v_A}{\partial A} = \frac{-1}{\partial V/\partial M}\left\{\frac{\partial^2 V}{\partial Q^2}(Q')^2 + \frac{\partial V}{\partial Q}\cdot Q''\right\}$$

Conventional assessment techniques impose $\partial^2 V/\partial Q^2 < 0$, that is, the marginal utility of higher environmental amenity levels is decreasing, which causes the first term in the brackets of (4) to be negative. If Q'' is negative, then the entire bracket is negative and hence $\partial v_A/\partial A > 0$, which is the conventional result. That is, increases in acidity require progressively increasing levels of compensation if a constant utility level is to be maintained. In short, the assumption that Q'' is negative, which means that marginal physical or biological damages are increasing, is sufficient, if large enough, to obtain a result that a little bit of acidification has only relatively minor economic consequences.

We have elsewhere noted (Crocker and Forster 1981, 1984) that this comforting and convenient result does not always exist when dealing with the acid deposition phenomenon. In aquatic ecosystems, there is strong reason to believe that $Q' > 0$ over a fairly broad interval of acidity. Acid deposition precursors exhibit a similar pattern with respect to their influence on atmospheric visibility. If these "nonconvexities" are sufficiently strong, then marginal economic consequences may be declining ($\partial v_A/\partial A < 0$), implying that increases in acidification become progressively *less* offensive.

As noted above, the entire brackets in (4) must be positive if $\partial v_A/\partial A$ is to be negative. A positive Q'' will not guarantee a negative $\partial v_A/\partial A$, since $\partial^2 V/\partial Q^2$ is typically assumed to be negative, i.e., the marginal utility of more environmental amenities is customarily treated as declining. For wine, food, and perhaps song, this is an innocuous assumption.[3] The assumption is much less innocent when dealing with environmental amenities. Two fishing trips in each of which 10 pounds of yellow perch are caught is unlikely to be preferred to a single trip in which a single 20-pound landlocked salmon is landed. Two moderately nice vistas will fail to provide the utility of a single sensational vista. In a recent study of the economic consequences of air pollution impacts upon a forest in southern California (Crocker 1985), it was found that marginal utility gains increase dramatically as tree injury symptoms become less apparent. There are, in fact, abundant arguments that nonconvexities originating in a positive sign being attached to $\partial^2 V/\partial Q^2$ are systematic and regular features of individual preferences. May (1954) showed that if the alternatives being considered are multidimensional, intransitivities may arise, unless, in a lexical fashion, one dimension always dictates choice. Other arguments are built upon either the unavailability of information about the consequences of alternative acts, or unwillingness or inability to process this information. The result is a "threshold of sensitivity" (Georgescu-Roegen 1936, 1958), or a "zone of indifference" (Luce 1956; March 1978), within which choices are randomly made or an "inertia of choice" prevails (Devletoglau 1971). The existence of these thresholds or zones has been supported for more than 100 years by psychophysical experiments involving human perceptions of sensory phenomena such as heat, light and sound. Fechner's law, which says that the strength of an undesirable sensation is proportional to the negative of the logarithm of the stimulus, is a staple of this experimental literature (Baird and Noma 1978). To the extent that acid deposition affects the aesthetic attributes of environmental amenities, the assumption that $\partial^2 V \partial Q^2$ is negative seems particularly shaky. A positive $\partial^2 V/\partial Q^2$ along with a positive Q'' guarantees in (4) that $\partial v_A/\partial A < 0$, which states that the marginal damages of acidity will be decreasing.

The above treatment is further complicated when one recognizes that, in order to minimize the burden, individuals will adjust their choice of x in response to a change in acidity. Some components of x will be increased, while others are reduced. For many of these components, their relationship to Q and hence acidity is not well understood. For example, the biologist might be able to specify the relation between acidity and fish biomass, but the impact of this relation upon aquatic-based recreation may be unclear. Recreationists may substitute across sites and even across activities.

The list of plausible misspecifications in (1) increases when it includes environmental amenities, and therefore the ambiguities in inferences about preferences drawn from estimates of demand functions arrived at by conventional techniques are readily expanded beyond the simple cases set forth here.

First, there is evidence (at least as portrayed in the natural science acid deposition literature) that $Q(A)$ may not be a smooth, continuous function, but rather a step function with threshold behaviour where discrete stocks of entire fish species are lost at specific acidity levels. Unfortunately, the natural science literature fails to specify the species biomass losses at these acidity thresholds, so that $Q(A)$ is rarely well defined. Consequently, v_A is not well-defined for the individual whose decision problem is depicted in (1).

Second, as defined in (1), M is no more than a combination of the individual's money income and the opportunity cost of his time. In a stock rather than a flow context, M is the individual's wealth. To include only money and time in wealth could be overly restrictive for those individuals blessed with easy access to environmental amenities. This could account for the order-of-magnitude discrepancies between compensating surplus and equivalent surplus value measures that have recently appeared in contingent valuation (bidding game) studies of environmental improvements, e.g., Schulze et al. (1983).

Third, the formulation of the decision problem in (1) fails to account for possible complementaries between the stock of Q and various private goods. Paraphrasing a nuts-and-bolts example from Hart (1980), suppose that a pristine aquatic ecosystem serves as an aesthetically pleasing input to the site-specific production of private musical performances and artwork. The ecosystem substantially reduces the artists' and performers' costs of attracting an audience to view and perhaps purchase their current and prospective work. However, if the ecosystem is allowed to decay, the unit costs of attracting an audience may exceed any artist's reservation price for producing art. Yet the minimum value of a combination of the

[3] In more formal terms, the requirement that $\partial^2 V/\partial Q^2$ be negative implies that preferences are transitive so that the Slutsky terms are symmetric.

square and the art may be much greater than the sum of reservation prices for them when treated separately. The setting that the aquatic ecosystem provides must be available at some minimal quality level in order for the art to be supplied. A benefit–cost analysis of artwork and performances based upon the price structure present when the ecosystem is badly polluted would give very different results that an analysis done with the pristine ecosystem present. The absence of the pristine ecosystem causes the *removal* (from existence) of another good from the commodity space available to each and every individual.

Fourth, the decision problem in (1) refers only to a single time period. Most impacts of acid deposition upon environmental assets and amenities will persist over several time periods. Some are plausibly irreversible. In these circumstances, it is tempting to calculate the income equivalents of changes in utility induced by changes in Q (or A), and to use the present discounted value of these income equivalents as a measure of the intertemporal welfare change. Blackorby et al. (1984), have recently shown that this exceedingly common procedure is "... never an exact welfare indicator..." when the individual is able to rearrange his borrowing and lending across time periods.

Fifth, interdependent preferences provide another plausible source of misspecification in (1). As Elster (1979) and Thaler and Shefrin (1981) suggest, certain kinds of current choices, such as education and handsome urban and rural environments, may cause me later to be what I now want to be later. This personal transformation can arise through deliberate acquisition of information or through the practice of "learning by doing." Minor modifications of any one of numerous extant habit formation models (e.g., Pollak 1976), seem likely to capture the essence of the problem. In these models, an individual's current preferences are made to depend on his past consumption. Additional modifications could allow one to explain how the current provision of certain environments may cause you later to be what I now want you to be later. This obviously raises the ancient spectre in economic analysis of interdependent preference orderings. Nevertheless, as long as individual X's preference ordering in any period is made to depend upon his *past* consumption, in principle, no problem arises. Individual Y, by his manipulation of X's current equilibrium consumption pattern, can then be represented as *producing* individual X's future preferences.

Sixth, environmental quality, as any natural scientist knows, may not be scaler-valued but rather vector-valued and the components of the vector may respond differently to variations in acidity.

Conclusions

The list of plausible misspecifications of the decision problems of individuals who enjoy environmental assets and amenities could be expanded substantially if we were to enter the domains of dynamics and uncertainty. We do not even pretend that the listing is complete for the comparative static context within which we have dealt. For example, how does one capture ecosystem diversity? Nevertheless, we hope our catalogue is long enough to convince the reader that techniques of benefit assessment do not come in neat packages that can be uncritically applied to valuations of environmental assets and amenities. These commodities are different, not just because they are typically nonmarketed. Individuals seem to approach them differently than shoes, socks, and shirts, whether pristine or otherwise. Consider Debreu's (1959) argument that if we suppose maximizing behavior, and observe stable market equilibria, then all our functions must have the appropriate convexity properties. We have no basis to believe that this tells us anything about the form of these functions when markets do *not* exist! Yet most benefit assessment techniques, when applied to environmental commodities, continue to draw an exact parallel with the argument of Debreu.

Our intent is most emphatically not a counsel of despair. It is simply a plea to research policymakers to allow some effort to be devoted to comprehending and, if need be, correcting the forms and sources of plausible misspecifications at least at the same time as one embarks upon a "number-generating" exercise. For Canada, the payoff to the patience this will require could be very substantial, since the majority of misspecifications appear to cause underestimates of the benefits of acid deposition control.[4]

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[4] To use the lucid phrases of Gensch and Svestka (1979), we believe that many of these misspecifications might be overcome if more attention is given to the "sequential noncompensatory" or lexical models of individual decision processes that dominate psychology. "Simultaneous compensatory" models currently rule the benefits assessment techniques of environmental economics. The lexical models are able to incorporate randomness and inertia of choice; they do not insist that the individual be cognizant of all mathematically unequal utilities. A first step in the task of integration and assimilation, then, is to bring together the array of psychological contributions relevant to understanding preferences and to place them into an analytical economic framework that embraces the constraints which scarcity imposes upon behavior.

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The Use of Indirect Techniques in the Analysis of Supply and Demand for Recreational Fishing

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Abstract

This paper looks at how various authors, in using indirect techniques of analysis, have dealt with the process of aggregating and pooling data across individuals and across sites. Lancaster originally suggested that demand curves be derived for attributes rather than for sites. Talhelm uses a two-stage process whereby data on attributes, access costs and visits is employed in discriminant analysis to group sites into commodity types. Talhelm then uses the same data, together with knowledge of users' incomes and preferences, to estimate demand functions for the commodity types. Morey on the other hand views visits to all sites as essentially the same and derives an equation in which expenditure shares on any one site depend on consumer attributes and incomes, the cost of access to a site and the attributes of that site. Morey assumes that unobserved attributes can be included in an error term enabling the estimation of a single demand equation which simplifies data requirements but requires a large number of simplifying assumptions.

The paper thus highlights the need to decide how much prior information, both in the explicit assumptions of the model and in the very process of conceptualizing the dimensions of the problem, can be tolerated in researching an empirical issue of great policy significance.

The paper also examines the applicability of the hedonic technique to evaluating the recreation experience on lakes. Since the technique was originally applied to areas where the impact of attributes was somehow reflected in market prices, there are problems when applying the method to recreation since no explicit markets or market prices exist. However, it is shown that the hedonic technique is nevertheless useful in the evaluation of sports fishing.

Résumé

Le présent document examine comment divers auteurs ont, à l'aide de techniques indirectes d'analyse, résolu le problème du rassemblement de données sur des personnes et des lieux. Lancaster a proposé initialement que les courbes de demande soient établies pour les attributs plutôt que pour les lieux. Talhelm utilise un processus à deux étapes par lequel les données sur les attributs, les coûts d'accès et les visites sont employées dans une analyse discriminante pour grouper les lieux dans des types de produits. Talhelm utilise ensuite les mêmes données, combinées aux revenus et aux préférences connus des utilisateurs, pour estimer les fonctions de demande pour les types de produits. D'autre part, Morey considère les visites à tous les lieux comme étant essentiellement la même chose et calcule une équation dans laquelle les parts de dépenses pour n'importe quel lieu dépendent des attributs et des revenus des consommateurs, du coût d'accès à tous les lieux et des attributs de tous les lieux. Morey suppose que les attributs non observés peuvent être inclus dans un terme d'erreur permettant l'estimation d'une équation à une seule demande, ce qui simplifie les exigences en données mais nécessite un grand nombre d'hypothèses de simplification.

Le document souligne ainsi la nécessité de décider quelle quantité d'information a priori, tant dans les hypothèses explicites du modèle que dans le processus même de conceptualisation des dimensions du problème, peut être tolérée au cours de la recherche effectuée sur une question empirique présentant une grande importance du point de vue de la politique.

Le document présente également l'applicabilité de la technique hédoniste pour l'évaluation de l'expérience récréative sur les lacs. Étant donné l'application de la technique à des secteurs où l'impact des attributs se concrétisait d'une certaine façon par les prix du marché, il existe des problèmes d'application de la méthode aux activités récréatives en raison de l'absence de marchés définis ou de prix de marchés. Cependant, il est démontré que la technique hédoniste est néanmoins utile pour l'évaluation de la pêche sportive.

My presentation consists of two parts. The first part looks at the following question. When we have many kinds of users and many lakes, the data needed to apply the indirect technique is large but can be much reduced by aggregating across individuals and across lakes. How have various authors dealt with this process and what are some of the underlying issues? My discussion is not intended as an exhaustive survey, nor do I pretend to get very far, but hopefully it will at least indicate some of the difficulties in a difficult area.

The second part introduces the hedonic technique, not so much as a serious contender for research, but as a device for making some observations which I believe are of much importance when trying to evaluate sports fishing.

Introducing knowledge of the attributes of lakes into conventional consumer and demand theory would, in principle, lead to specifications of demand functions that include not only "prices" of all sites, consumer incomes and tastes (age, sex, fishing experience, etc.) but also the attributes of each and every site. There would be an obvious increase in the explanatory power of the model but at the cost of greatly increasing the number of coefficients to be estimated. With one demand function for each lake and many lakes in existence, even the system of more conventional demand curves would be impractical. Besides, there is typically too little variation of attributes at a given lake to make time series data (were it to exist) of much use econometrically.

The question then is how best to use information on attributes in a cross-sectional analysis.

Put differently, if the individual's utility function is of the general form:

$$U_k = U_k (v_i, z_{ij}, h_k)$$

Where v_i = visits (by person k) to site i, $i = 1 \ldots n$
z_{ij} = attributes of type j at site i, $j = 1 \ldots m$
h_k = attributes of individual k (a vector)

the question is, what restrictions must we make a priori to get a manageable problem?

The first and most common assumption is that the utility function is the same across individuals, implying that people with exactly the same attributes (age, experience) have the same preferences. Furthermore, since data are only available for a subset of personal attributes, it is assumed that the impact of the unobserved attributes can be incorporated into an error term. It is in this sense that we talk of consumers having "identical tastes," an assumption which allows pooling of cross-section data for individuals. However, we do have the option of estimating different equations for subsets of the consumers, if we believe that they are quite distinctive in their behaviour.

Having thus rationalized pooling of individual data, how can we handle differences across lakes? Lancaster's (1966) original suggestion was to derive demand curves not for sites but for the attributes. The utility function is specialized into:

$$U = U(Z_1 \ldots Z_n, h_k) \quad \text{where} \quad Z_j = \sum_{i=1}^{n} v_i z_j$$

Thus, Z_j might be the total catch of rainbow trout across all lakes by an individual (or an individual community, if we do not have seasonal data). The independent variables are the implicit relative prices of attributes, which are generated from data on access costs and site attributes, assuming a linear technology. In this way the econometric problem is reduced to estimating as many equations as there are important characteristics. Unobserved or unique attributes of lakes are assumed to influence the size of the error term. This formulation has the added advantage of directly estimating the demands for fishing quality.

Talhelm's solution is to use a two-stage process whereby data on attributes, access costs and visits is employed in discriminant analysis to group sites into commodity types, and then use the same data, together with knowledge of user's incomes and preferences, to estimate demand functions for the (reduced) number of commodity types. The technique seems to me to be most appropriate when two or three characteristics dominate consumer perceptions and where the lakes themselves are found to naturally bunch into distinct groups along any one dimension (such as size of lake). Since so much of the work goes into the grouping of commodities, which tends to be generated with little explicit use of prior information or theory, it is perhaps hard to evaluate the final product and one must have considerable confidence in the craftsmanship of those doing the study (which in this case I hasten to add, I do).

I wish, however, to concentrate your attention on a specific study by Morey (1981) who approaches the problem quite differently. Morey essentially follows Lancaster's framework but estimates expenditure shares on site. He proceeds as follows. Each trip (skiing in this case) constitutes an "experience", the quality of which depends on site attributes and the attributes of the user, and it is assumed that the contribution of these variables to quality is the same across all sites, thus:

$$U = U(v_i, E_i), \text{ where } E_i = H(Z_i, h_k).$$

E_i is the quality of the experience and H is the same for all sites (with a specific functional form being used). Furthermore, U is additively separable *across* sites, but not for the same sites, i.e. $U = \Sigma u(v_i, E_i)$, implying that previous visits to the *same* site influence the utility of another trip, but that previous visits to other sites do not (an implausible assumption!).

To justify the pooling of this data not only across individuals but across sites, Morey has to assume that any unobserved attributes can be thrown into the error term and that error terms are statistically independent from the explanatory variables and from each other. Whereas Talhelm would view visits to different sites as essentially different commodities (unless the sites belonged to the same group), Morey in effect views visits to all sites as essentially the same. The justification would be that insofar as the sites are known to be different, this is explicitly allowed for, whereas unrecorded differences must be presumed to be unknown and randomly distributed.

The above assumptions have materially simplified the statistical problem, for now Morey could derive an equation in which expenditure shares on any one site depend on consumer attributes and incomes, the cost of access to all sites *and the attributes of all sites*. But Morey now goes one step further by borrowing from the theory of discrete choice (logit/probit analysis) the assumption that the error term has a specific and known form. With this assumption, he is able to derive his final single equation to be estimated, which has expenditure share by an individual on a specific site depending only on that site's characteristics and cost of access to that site, as well as the individual's characteristics. With this dramatic collapsing of the problem, Morey is then able to satisfactorily estimate demands for ski-sites using less than 1000 visits in all from a small number of skiers. The cost has been a whole series of simplifying assumptions.

The primary reason for this synopsis is that it highlights the need for a group such as this to decide how much prior information in the form of theoretical assumption can be tolerated in researching an empirical issue of great policy significance. Put differently, are policy makers, and particularly those opposed to one's findings, simply going to reject any conclusions either because they cannot understand or are not convinced by the underlying reasoning? One of the key advantages of the direct method is that the answers are more readily intelligible to all and sundry.

Morey (and Lancaster) require detailed consumption data from individuals, that is, data over a season. Frequently we are only able, or it is easier, to get cross-section data of visits to sites in a short time interval. Each consumer only in fact visits one site. One approach is to treat the cross-section data for one origin as representative of the typical individual's consumption basket: if 30% of the community visits site "j", then we assume a typical individual spends 30% of his visits (over a season) at site "j". One may then be obliged to use averages for the community — such as average income — to represent "individual" characteristics, a great waste of information about individuals. An alternative approach is to model the discrete choices of individuals using probit or logit analysis, originally designed to explain choices among travel modes.

Applying such analysis to large numbers of destinations is, I gather, computationally difficult. I would rather like to highlight the role of theory in such analysis. In this analysis, you get the same result, that the ratio of the probabilities of visiting any two sites is independent of the attributes or prices of any other site, and one estimates that ratio. The key assumptions are that the error terms have specific functional forms and that preferences display "irrelevance of alternatives." This latter assumption means that the relative

attractiveness of any two sites is independent of the presence or absence of a third. To add an additional competing site causes a decrease in demand for both sites, but does so proportionately. This in turn requires that the third site be as distinct from the first two sites as they are from each other. Thus, in analysing travel modes, one might use the technique to compare car versus bus versus train, but not red coloured cars versus blue cars versus trains. The researcher has to use his common sense in judging that, with respect to those attributes that are *not* explicitly modelled, there is the required distancing between commodities. (See Amemiya (1981) for a valuable survey of discrete models).

Discriminant analysis, as a statistical technique, is another branch of the discrete theory. It was developed to answer the following question: if one *knows* a priori that nature has discontinuities, such as between men and apes as species, how can one tell from a single observation, such as the size of a skull, whether that observation belongs to one group or the other, bearing in mind that some men have small skulls and some apes large ones? The relationship between this use of discriminant analysis and that of Talhelm is unclear to me. What is clear is that the problem addressed by Talhelm as to when we can group our data and treat them as distinct commodities is a profound one. What is also clear is that we shall of necessity have to rely on a priori information, common sense, and the good judgement of those carrying out the research, as to when and where to draw the lines.

Thus, the final conclusion of this section is that application of the indirect technique in this area must involve much use of a priori information, both in the explicit assumptions of the model and in the very process of conceptualizing the dimensions of the problem. While as an academic I can happily live with this, can we expect policy-makers to do so?

The second half of my presentation concerns the applicability of the hedonic technique, more narrowly defined, to evaluating the recreation experience on lakes. This technique was originally introduced to model markets where product quality varied and where consumers bought only one unit. Thus the "hedonic function" in the house market is the observed relationship between the prices people pay for houses and the "size of the house," "the number of bathrooms," "distance from shopping facilities," etc. The technique has been successfully extended to include environmental variables such as noise pollution. In each instance, it is presumed that the impact of attributes is somehow reflected in market prices. The applicability to recreation, for which there is no explicit market or market price, is problematic, because, although travel cost is a proxy for price, it clearly does not vary according to demand. I hope to indicate that the technique is nevertheless useable, in principle.

Suppose in a pristine state sportsmen suddenly had access to sites of varying quality as shown by the dots on Fig. 1. Fishermen with indifference curves shown as N would clearly favour sites 1 and 2 exclusively. If, however, sites were marketed via admission charges, costs inclusive of charges would *adjust* as shown in Fig. 2, and an "hedonic function" would emerge.

If site owners were free to adjust quality, by allowing excess fishing or by stocking, they would adjust quality to maximize profit. Using Rosen's (1974) analysis, we show in Fig. 3 how for any hedonic function, the owner seeks that quality which maximizes his profits. If consumer preferences are identical, this will not stop the hedonic function from being interpreted as indicating preferences, but if tastes

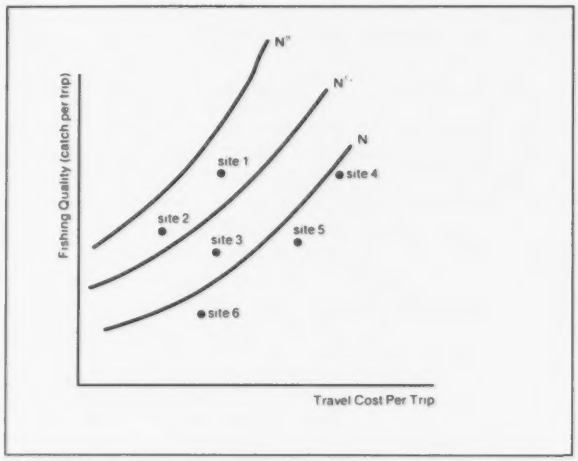

FIG. 1. In a pristine state, with no admission charges, users concentrate on the few most attractive sites (sites 1 and 2).

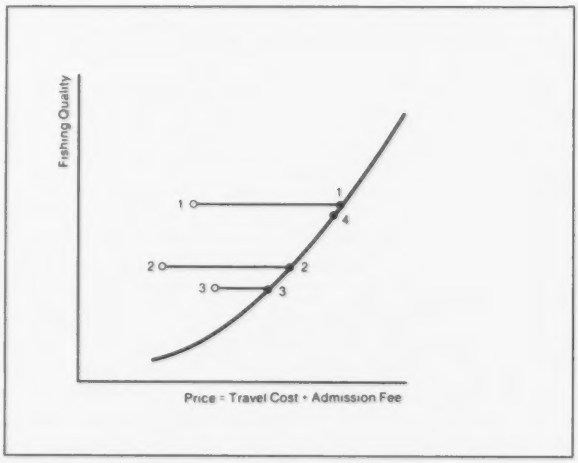

FIG. 2. The emergence of a market causes costs inclusive of admission charges to rise so that many sites are now being visited. The resulting equilibrium is the *hedonic function*, and if all consumers are identical all lakes used lie on an indifference curve. The hedonic function reveals preferences. (Note, the quality is assumed to be unchanged.)

differ and the intrinsic quality of sites differ, the hedonic function will simply be an amalgam of supply and demand forces. The classical identification problem emerges and can only be resolved by explicitly modelling both demand and supply forces. This is the first point I wish to make, namely, that all the techniques we are discussing today systematically ignore the fact that fishing quality, for instance, is very much an endogenous variable. The identification problem is a very serious one.

Returning to our assumptions of identical preferences, how would an hedonic function apply in our *non-market* situation? It is precisely through quality adjustments that one could still envisage as hedonic functions, for if any site was preferable to others, all consumers would visit, thus presumably pushing down the quality of fishing. As shown in Fig. 4, quality adjustments play the role attributed to price adjustments in Fig. 2, and once again the hedonic function reveals consumer preferences. The absence of a market is not prob-

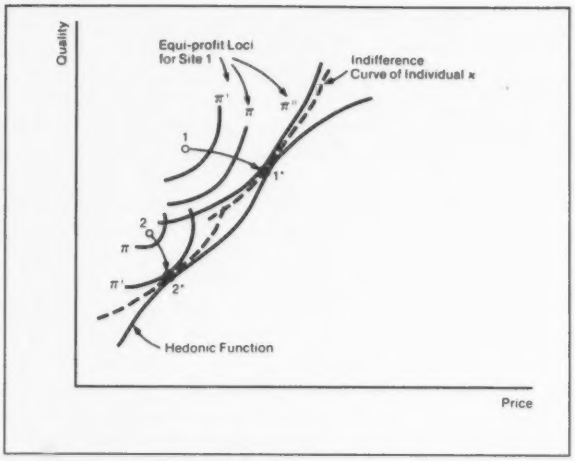

FIG. 3. Where quality is adjustable owners seek the most profitable price quality mix, while different consumers choose highest indifference curves. The outcome is the hedonic function, as an amalgam of supply and demand forces. This is the identification problem, as analysed by Rosen (1974).

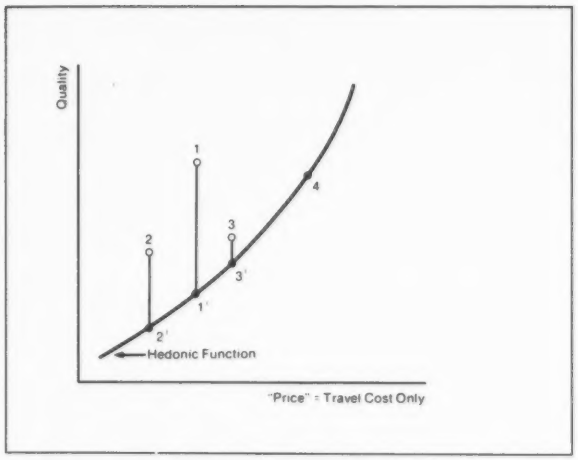

FIG. 4. Even though sites are not owned, if quality adjusts on its own we can still get an hedonic function which represents consumers' preferences, if all consumers are identical.

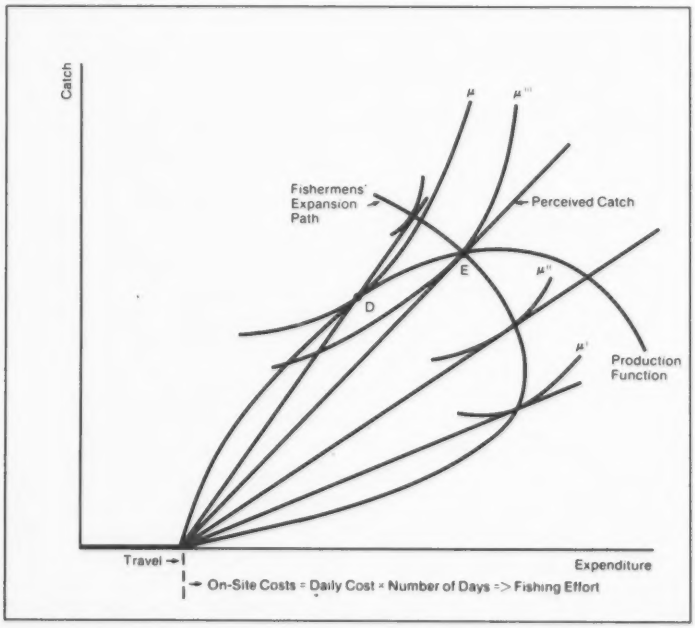

FIG. 5. Rental dissipation, at a given site. The indifference curves represent the "representative" consumer's preferences. The production function is the (long-term) catch per trip as a function of the fishing effort per fisherman (it is therefore sensitive to the number of fishermen). Each individual, since he is only one of many, perceives his catch to be a linear function of his "effort" or trip duration. In fact since many individuals are fishing the actual yield is sensitive to effort, as shown by the production function. Long-term equilibrium is at E with utility of U''': the optimal point is at D: the loss of potential utility constitutes a dissipation of rents.

lematic for this technique *provided long-run adjustments in quality have taken place*. Note that if quality adjustments did not take place, then consumers would concentrate on a few sites. The presence of users of other sites would simply be due to the random error term in tastes and any statistical fit, were one to arise, would be spurious.

To add a little more structure to this analysis, let us assume each trip consists of a fixed travel cost and a fixed daily cost, when on site. Only one trip is to be taken, but its length can be varied. Furthermore, let us explicitly allow for total catch per person per trip to vary with the number of users and the duration of those trips. For the moment, assume only one site

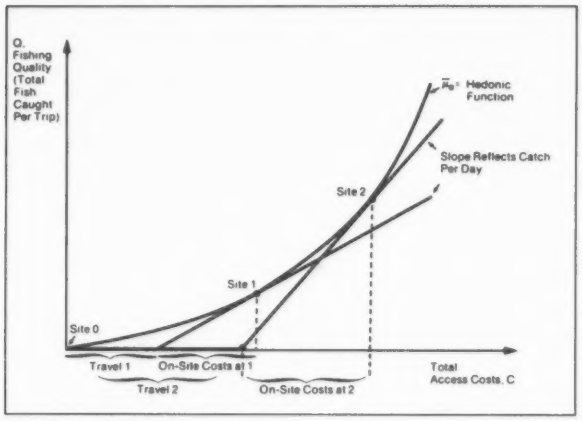

FIG. 6. This figure shows how the non-convexity of the budget-line that is introduced by the travel cost component, can produce an hedonic function that conforms to an indifference curve such that a user is indifferent as to whether he stays at home (site 0) or visits any other sites. Although persons spend considerable sums on fishing there is no consumers' surplus.

Note that although it is true that fish caught increase with distance (or travel costs), it is not necessarily the case that trip duration would increase with distance.

is available. Figure 5 shows that with a given number of users, the equilibrium of catch and effort will not be efficient: the common property feature of sports fishing leads to obvious wastes and any observed consumer surplus clearly understates the potential from a site. The damage caused by acid rain may be more in its destruction of potential than actual rents.

But now let there be many users, and if one likes, many sites. Then we would once again get identical consumers participating by fishing different sites, with the further sites having higher quality. Fishermen from the Toronto region should have found that the quality of fishing systematically rises the further north they travel. But what is more important is that all *consumers' surplus would be eliminated* if the pressure of fishing is extensive. This is shown in Fig. 6. I have always found it incongruous that whereas economists place great stress on the rental dissipation of commercial fishing under free-access, that they somehow minimize the consequences of free-access in sports fishing. What this analysis shows is that the presence of some non-convexity in the budget constraint means that there is no natural limitation on the extent of "rental" dissipation in sports fishing.

In conclusion, one gets the impression that applications of the indirect technique, already quite esoteric, can and will undergo considerable refinements, whereas some more basic aspects of the supply side are more neglected.

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Évaluation des dommages socio-économiques potentiels causés par les précipitations acides sur la pêche sportive au Québec

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Résumé

Dans cette présentation, M. Gautrin expose dans ses grandes lignes le contenu d'une étude réalisée en 1982 pour le ministère de l'Environnement du Québec.

Après avoir cerné l'importance économique de l'activité de la pêche sportive au Québec (population de pêcheurs, pression de pêche, dépense des pêcheurs, etc.), Econosult a développé un cadre théorique d'analyse d'impact qu'il a appliqué à cinq sites. L'impact économique de la pêche sportive et les pertes potentielles dues aux pluies acides se sont avérés relativement importants pour les cinq villages choisis en fonction de leur situation géographique (ils constituent des portes d'entrée à de grandes zones de pêche, ZEC ou zone d'exploitation controlée).

Enfin, M. Gautrin a recours à des considérations méthodologiques théoriques relatives aux principales méthodes existantes pour évaluer les bénéfices et la valeur de la pêche sportive.

Abstract

In this paper, Mr. Gautrin highlights the contents of a study conducted in 1982 for the Quebec Department of the Environment.

After determining the economic importance of sport fishing in Quebec (population of fishermen, fishing pressure, expenditures by fishermen, etc.), Econosult developed a theoretical impact analysis framework which they applied to five sites. The economic impact of sport fishing and the potential losses due to acid rain proved relatively significant for the five selected towns in respect of their geographical location (they are gateways to major fishing zones (i.e., controlled harvesting zones)).

Mr. Gautrin concludes by examining theoretical methodological considerations concerning the principal existing methods for assessing the benefits and value of sport fishing.

Dans les brèves notes qui suivent, je voudrais vous résumer le contenu de l'étude que nous avons réalisée en 1982, pour le ministère de l'Environnement du Québec, et par la suite indiquer les avenues de recherches qui je pense être les plus fructueuses.

L'étude intitulée « Évaluation des dommages socio-économiques potentiels causés par les précipitations acides sur la pêche sportive au Québec » fut complétée en mars 1982, par Econosult Inc. pour le compte du ministère de l'Environnement du Québec. Plus particulièrement, l'étude poursuivait les quatre objectifs suivants :

1. Évaluer l'importance économique de l'activité de la pêche sportive au Québec et plus particulièrement de la rive nord du fleuve Saint-Laurent;
2. Développer un cadre théorique d'approche pour évaluer l'impact économique potentiel d'une détérioration progressive et même de la destruction de la ressource pour un ou plusieurs sites choisis (Saint-Michel-des-Saints, Ferme-Neuve, Saint-David-de-Falardeau, Les Escoumins, Rivière-à-Pierre);
3. Appliquer le cadre d'approche pour cinq sites choisis;
4. Conclure sur les résultats de l'expérience et évaluer les possibilités d'accroître la qualité des résultats recherchés.

Donc, soyons très clairs à ce stade-ci, il ne s'agissait pas à proprement parler d'évaluer le prix de la pêche sportive, mais bien plutôt de situer l'importance de l'activité économique pêche sportive, et surtout à l'aide des scénarios de détérioration, d'estimer l'impact économique local entraîné par la réduction de la pêche sportive.

En effet, pour calculer la perte, il faut modifier la valeur des impacts de la façon suivante :

- imputer à la dépense la part véritable attribuable à la pêche sportive;
- ajuster, par région, les pertes de revenus donc les pertes de masse salariale, donc des réductions d'emplois, en tenant compte du coût d'opportunité de la main-d'oeuvre (c.-à-d. *shadow pricing*).

L'activité économique « Pêche sportive » au Québec

Tous les résultats présentés ici sont basés sur l'enquête du MLCP réalisée en 1980 auprès de 5 500 ménages sur tout le territoire du Québec concernant la pêche, la chasse, et le piégeage (Pelletier et coll. 1981). Les résultats principaux sont regroupés dans l'encart suivant.

En 1980, population des pêcheurs	1 200 000
Pression de pêche	13 000 000 jours de pêche
Niveau moyen d'activité	10,4 jours de pêche
Taux de participation	19,4 %
Âge moyen du pêcheur	36 ans
Caractéristiques générales du pêcheur	légèrement plus éduqué, plus riche
Dépenses totales des pêcheurs québécois (Nourriture, transport, et hébergement constituent 82 % du total)	251 M $
Dépenses totales de pêcheurs non résidents	24 M $

Emplois indirects créés par la dépense	5 258
Effets indirects en valeur ajoutée	144 M $
Multiplicateur de revenu	1,57

Le multiplicateur de revenu de dépenses est 1,57. La valeur de l'activité économique pêche sportive est d'environ 250 millions de dollars, une dépense par jour de pêche de 20 $. L'impact macro-économique estimé par le modèle intersectoriel du Québec ne constitue évidemment pas la valeur de la perte pour la société si la pêche sportive venait à disparaître demain.

Impact économique potentiel des précipitations acides sur la pêche sportive auprès de cinq municipalités du Québec

L'objectif de la présente étude est ici parfaitement clair. Il s'agit au niveau microéconomique (5 municipalités) d'estimer la perte de revenus et d'emplois suivant soit la disparition complète de la pêche sportive ou les niveaux de détérioration croissants.

Pour ce faire, nous avons réalisé une enquête dans les cinq municipalités auprès des pourvoyeurs, des commerçants et autres fournisseurs de biens et de services. Le questionnaire, qui comprend 14 questions, a été communiqué à 118 entreprises ou commerces par la poste ou en main propre.

Les cinq villages (Saint-Michel-des-Saints, Ferme-Neuve, Saint-David-de-Falardeau, Les Escoumins et Rivière-à-Pierre) ont été choisis car en plus de dépendre du tourisme et de la pêche, ils constituent les portes d'entrée principales à de grandes zones de pêche (ZEC).

Le choix des entreprises interviewées et la détermination des zones d'influence s'est fait en consultation avec le MLCP.

Les résultats – synthèse de l'enquête sont résumés dans le tableau 1 suivant. L'enquête en soi ne fournit que la réduction des revenus (baisse du chiffre d'affaires du cas extrême) de la disparition totale de la pêche sportive. L'analyse biologique nous a permis de déterminer le rythme de détérioration (c.-à-d. le degré d'acidification) de lacs compris dans la zone d'influence de chacune des municipalités choisies. Les lacs ont été classés en trois catégories (sensible, intermédiaire et résistant) en fonction de l'évolution prévisible des populations d'espèces exploitées par la pêche sportive.

Le classement tout d'abord basé sur la taille et le type de bassin versant a été corrigé en fonction des données sur le pH des lacs et des espèces présentes (pH $>$ 6,5 était généralement associé avec un lac résistant). En se basant sur le rythme de détérioration observée en Ontario, des scénarios d'évolution furent établis. Les scénarios d'évolution donnent pour les années 1987 et 1994 le pourcentage de pêche sportive perdue. Ce pourcentage est une estimation qui dépend donc de la distribution des lacs par type corrigée par les plans d'eaux impliqués (voir tableau 2). Pour traduire cette perte en valeur on a supposé une simple règle de proportionalité.

Commentaires sur les résultats

a) Il fut toujours difficile d'établir les pourcentages de la clientèle et du chiffre d'affaires qui proviennent du tourisme et de la pêche sportive.

b) Les données sur le chiffre d'affaires conduisent plutôt à une sous-estimation de l'impact.

c) Ce qui est mesuré, c'est localement l'impact direct; aucun effort n'a été réalisé pour estimer un multiplicateur local et donc de calculer les impacts indirects locaux.

d) L'analyse conduite suppose une directe proportionalité entre détérioration physique, réduction de la pêche sportive, et impact en valeur. Ainsi, l'effet d'ajustement des pêcheurs (qui se déploraient) étant ignoré, cela conduit à une certaine surestimation, peut-être temporaire, de l'impact.

Conclusions de nature méthodologique

La démarche dont nous venons de parler, encore une fois, ne constitue qu'une mesure de l'impact local dû à la détérioration ou la disparition de la pêche sportive.

TABLEAU 1 Les résultats – synthèse de l'enquête.

Région	Saint-Michel-des-Saints	Ferme-Neuve	Saint-David-de-Falardeau	Les Escoumins	Rivière-à-Pierre
Population permanente en 1981	1 960	2 113	1 980	2 200	690
% du chiffre d'affaires provenant de la pêche sportive	21 %	18 %	36 %	25 %	49 %
Pertes de revenus (s'il n'y avait plus de pêche sportive)	2 280 000 $	1 193 450 $	2 514 000 $	1 174 590 $	639 250 $
Pertes de revenus (en % des revenus totaux des entreprises enquêtes)	23 %	16 %	37 %	16 %	58 %
Pertes d'emplois (en personnes-année)	34	13	35	30	7
Pertes de revenus potentielles pour les entreprises (en $ 1982)					
1982	0	0	0	0	0
1987	843 600 $	298 400 $	1 885 500 $	234 900 $	191 800 $
1994	1 140 000 $	895 100 $	2 514 000 $	704 800 $	415 500 $

TABLEAU 2 Effets des précipitations acides, pourcentages de perte du potentiel de pêche sportive : hypothèses de travail.

Région	Sous-division	1982	1987	1994
Ferme-Neuve	SW	0	0	0
	NW	0	25 %	75 %
Saint-Michel-des-Saints		0	37 %	50 %
Rivière-à-Pierre		0	30 %	65 %
Les Escoumins		0	20 %	60 %
Saint-David-de-Falardeau	ZEC Boiteuse Territoire libre Territoire d'Air Saguenay	0	15 %	30 %
	ZEC Onatchiway Est	0	75 %	100 %

Les avantages de telles études sont certains. En effet, l'on peut ainsi connaître la distribution géographique des dépenses de la pêche sportive au Québec, ce qui peut être particulièrement avantageux pour des fins de développement régional.

Par contre, si la question que l'on se pose est le bien fondé de la mise en place des solutions, programmes, mesures qui viseraient à préserver la pêche sportive, alors ce sont des analyses bénéfices-coûts qui doivent être réalisées, les bénéfices (au niveau de la société) étant les épargnes réalisées à maintenir la pêche sportive.

Dans le domaine de la pêche sportive, quatre méthodes existent pour calculer les bénéfices :

a) La méthode des dépenses;
b) La valeur « hédonique »;
c) la méthode de Talhelm;
d) L'estimation du surplus du consommateur par enquête.

Chacune de ces méthodes veut estimer la valeur de la pêche sportive; chacune de ces méthodes a ses avantages et ses défauts.

La méthode des dépenses, comme son nom l'indique, vise à égaler le prix de la pêche sportive pour toutes les espèces données, sur un territoire comme Québec, pour une période (disons d'un an) avec le montant total des dépenses faites par tous les consommateurs pour (et seulement pour) la pêche sportive. Il est évident qu'une telle méthode néglige le surplus du consommateur (le fameux triangle sous la courbe de demande) et devrait donc systématiquement conduire à une sous-estimation de la valeur de la pêche sportive. Par contre, à mesure que le temps passe, les consommateurs sont à même de substituer la pêche sportive par un autre bien si bien que la mesure de la valeur de la pêche sportive est moindre que le flux cumulé des dépenses temporelles pour la pêche sportive. En plus des problèmes théoriques mentionnés plus haut, l'une des difficultés empiriques consiste à isoler les dépenses vraiment spécifiques à la pêche sportive.

La méthode de la valeur « hédonique » consiste à supposer qu'il y a moyen d'isoler, à travers des transactions sur un marché donné, la rente attribuable à un bien comme la pêche sportive. Bien sûr, l'hypothèse maîtresse est que ce marché existe; ici on supposera que le marché des propriétés foncières attribue un prix implicite à la pêche sportive. Ainsi la valeur de la pêche sportive devrait être mesurée par la différence dans la valeur des propriétés entre deux terrains situés au bord d'un lac qui, par ailleurs, aurait toutes les mêmes caractéristiques. Les problèmes d'estimation sont ici évidemment très sérieux; la méthode ne vaut que dans un espace géographique où il existe des transactions et un marché (c.-à-d. ne peut mesurer la valeur de la pêche sportive dans le Grand Nord canadien).

La méthode de Talhelm permet d'estimer les variations dans la valeur d'une ressource comme la pêche pour les utilisateurs de la ressource. Il s'agit d'estimer simplement des fonctions de demande qui tiennent compte essentiellement des coûts de transport des usagers. La méthode de Talhelm a une différence (hormis les problèmes usuels d'estimation) : c'est qu'elle ne tient pas compte de la valeur de la ressource pour les non-usagers (« *existence value* » — « *option value* »).

La méthode de l'estimation du surplus du consommateur par les « montants à payer ou à recevoir » (*willingness to pay*) est bien connue. Cette méthode n'est évidemment pas exempte des problèmes de correlation du revenu tandis que l'autre peut également conduire à des problèmes de surestimation, étant donné que les consommateurs ne font pas face d'un seul coup à l'estimation de leurs surplus pour tous leurs biens consommés.

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The Economic Impact of Acid Rain on the Commercial Atlantic Salmon Fishery

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Abstract

This paper presents an overview of the commercial Atlantic salmon fishery in Nova Scotia. The number of licensed fishermen is steadily dropping, partly as a result of an attrition policy by DFO (currently there are 225 licensed fishermen). Acid rain, so far, appears to have affected mainly rivers flowing across mainland Nova Scotia into the Atlantic Ocean by lowering the pH level to such an extent that some rivers no longer support a salmon population. Others are experiencing pH levels in the 4.7 to 5.0 range, which threatens existing salmon stocks.

A model of the fishery was developed with two special features. The supply of salmon in any one year is regarded as biologically determined. This is expressed as a completely inelastic supply curve at a given output level. The cost of harvesting salmon is assumed to consist of a large fixed-cost component. An average cost curve is introduced to help derive the total cost of harvesting different levels of output. The net social surplus generated by the fishery is shown to be a combination of consumers' surplus and resource rent. When acid rain is introduced into the model, it causes the inelastic supply curve to shift to the left, indicating a lower output of fish, other things being equal. The economic cost of acid rain is derived as the change in the value of the net social surplus, which is the combined effect of the change in consumers' surplus and the change in resource rent.

Preliminary results establish clearly that commercial salmon fishermen sell their catch to a wide variety of buyers, including households, hotels, restaurants, stores, processors and themselves. Intepreting the salmon demand curve and the official salmon data requires further work. The postulated cost curve with a large fixed cost component appears to be a correct interpretation of the commercial salmon fisherman's cost structure according to interview results. The revenue and cost estimates show that on average the commercial salmon fishermen did not cover the estimated opportunity cost of salmon fishing in 1983. However, some individual salmon fishermen in the sample did earn a surplus in excess of their opportunity costs. It is suggested that in good years the fishery could generate a surplus or resource rent in excess of opportunity cost. Additional work is required to check the estimates of opportunity cost, to relate these results to the acid rain issue and to determine the relevance of the fishermen's attitude toward the fishery, including the worker's satisfaction bonus.

Résumé

Le présent document offre un aperçu général de la pêche commerciale au saumon atlantique en Nouvelle-Écosse. Le nombre de pêcheurs, détenteurs de permis, décroît régulièrement, en partie à cause d'une politique d'attrition appliquée par le MPO (actuellement, on compte 225 détenteurs de permis parmi les pêcheurs). Jusqu'à présent, les pluies acides semblent avoir surtout modifié la condition des rivières qui traversent la Nouvelle-Écosse continentale pour se jeter dans l'océan Atlantique, en abaissant le pH à tel point que la population de saumon est disparue de certains cours d'eau. D'autres présentent des valeurs de pH variant de 4,7 à 5,0, ce qui menace les stocks existants de saumon.

Le modèle de pêche, qui a été élaboré, présente deux caractéristiques spéciales. L'approvisionnement en saumon au cours d'une année particulière est considéré comme déterminé biologiquement. Cette valeur est exprimée par une courbe d'approvisionnement totalement constante à un niveau donné de production. On suppose que le coût de la récolte de saumon comporte une importante composante de coût fixe. Une courbe de coût moyen est introduite pour faciliter le calcul du coût total de la récolte de diverses quantités de production. Le surplus social net produit par la pêche est indiqué comme une combinaison du surplus du consommateur et du loyer de la ressource. Lorsque les pluies acides sont introduites dans le modèle, la courbe d'approvisionnement constante se déplace vers la gauche, indiquant une production inférieure de poisson, toutes choses étant égales par ailleurs. Le coût économique des pluies acides est obtenu sous la forme du changement dans la valeur du surplus social net, qui est l'effet combiné de la modification du surplus du consommateur et de celle du loyer de la ressource.

Les résultats préliminaires établissent clairement que les pêcheurs commerciaux de saumon vendent leurs prises à un large éventail d'acheteurs, à savoir les ménages, les hôtels, les restaurants, les magasins, les entreprises de transformation ainsi qu'eux-mêmes. L'interprétation de la courbe de la demande de saumon et les données officielles sur ce poisson exigent des travaux complémentaires. La courbe de coût hypothétique comportant une importante composante de coût fixe semble être une interprétation correcte de la structure des coûts du pêcheur commercial de saumon, d'après les résultats d'entrevues. Les estimations des recettes et des coûts montrent qu'en moyenne, les pêcheurs commerciaux de saumon n'ont pas couvert le coût estimé d'option de pêche au saumon en 1983. Cependant, certains pêcheurs de saumon dans l'échantillon ont gagné un surplus dépassant leur coût d'option. Il est proposé qu'au cours des bonnes années, la pêche pourrait engendrer un surplus ou loyer de ressource dépassant le coût d'option. D'autres travaux sont nécessaires pour vérifier les estimations du coût d'option, pour établir un rapport entre ces résultats et la question des pluies acides, et pour déterminer la justesse de l'attitude du pêcheur face à la pêche, y compris la prime de satisfaction du travailleur.

What I'm reporting on is a study that is currently underway for the Department of Fisheries and Oceans that was to attempt to come up with a valuation for the salmon fishery in Nova Scotia, both the sport and the commercial segments of it, and to then look at what have been the economic losses imposed by acid rain up to this point and what might be some future losses if things go on more or less as they have been.

Nature of the Fishery

Compared with the commercial fishery for Atlantic

TABLE 1. Nova Scotia commercial catch, compared with New Brunswick and Newfoundland, Nova Scotia sport catch and number of licensed fishermen in Nova Scotia for selected years.

Year	Nova Scotia licensed commercial salmon fishermen[a]	Commercial catch[b]			Sport catch
		N.S. (t)	N.B. (t)	Nfld. (t)	N.S. (t)[c]
1970	N/A	52	258	1 595	22
1975	N/A	57	—	2 044	16
1980	276	62	4	2 102	38
1981	254	31	101	1 910	46
1982	229	49	80	1 320	30
1983	225	36	N/A	1 016	N/A

SOURCE: [a]DFO, Redbook, various years (includes commercial catch caught with salmon gear only).
[b]DFO, Annual Statistical Review, various years (may include salmon caught with "other" gears).
[c]Estimated by assuming an average weight of 4.54 kg. per salmon.

salmon in Newfoundland and New Brunswick, the Nova Scotia commercial fishery is small. Estimates of catch level by the Department of Fisheries and Oceans for recent years are shown in Table 1. Based on the historical record and what is known about the capacity of Nova Scotia rivers to support stock rejuvenation, there is little likelihood the commercial salmon catches will increase significantly in the foreseeable future, although some increases are possible, provided the commercial fishing effort is maintained.

Commercial catches of Atlantic salmon are not uniformly distributed across Nova Scotia. Four areas contain the most productive segments of the fishery:

a) the mainland Atlantic coast from Guysborough County west to Lunenburg County;

b) the Atlantic coast of Cape Breton Island;

c) the Gulf of St. Lawrence–Northumberland Strait area, comprised of the western shore of Cape Breton and Antigonish and Pictou counties; and

d) the Minas Basin.

Indeed, as might be expected, the heaviest catches occur in coastal areas adjacent to salmon rivers and near headlands around which the salmon must pass on their journey to their home rivers. In decreasing order, the largest catches occurred in districts 13, 2, 1, 7, 12, 22, 4, 17, 27 and 3. These districts are shown in Fig. 1. They account for 91% of the total catch, based on the average catch by district for the 12-year period 1970 through 1981.

Three distinct gear types are employed by commercial salmon fishermen. Salmon traps, some specifically designed for the salmon fishery, others adapted from other fisheries, are by far the most popular, accounting for 80% or more of the total harvest in most years. Another 10–15% is caught by gill nets. Drift nets, used primarily in the Minas Basin or its tributary rivers, account for the remainder.

Currently, there are 225 licensed commercial salmon fishermen operating in the province. This number is declining in large part because of the DFO licensing policy, which is primarily one of attrition. No new licenses are granted and existing licenses can not be transferred if a fisherman dies or chooses to discontinue fishing for salmon.

Harp seals pose a significant problem for commercial fishermen in some areas along the Atlantic coast. The seals raid the salmon gear to help themselves to an easy meal. They can cause considerable damage to nets. Consequently, in these areas the fishermen must tend their gear regularly. In some cases they must actually remain with the gear while it is in the water.

Acid Rain and Salmon in Nova Scotia

Data available for Nova Scotia indicate that the annual mean rainfall pH has declined from 5.7 to the 4.4 to 4.6 range since 1952–54. Depending on the geology of a given area and, therefore, on its neutralization capacity, Nova Scotia rivers have been affected differently by acid rain. In Nova Scotia, about one-half of the land area is underlain by granitic and metamorphic rocks, which have been associated with low water pH. These rocks are mostly encountered on the Atlantic side of the province, resulting in the concentration of rivers of low mean pH in this area. Cooley (1986) shows the distribution of Nova Scotia rivers according to water acidity.

Rivers with pH levels below 4.7 run in areas with negligible neutralization capacity. Their mean pH levels are, in fact, on a level similar to that of the rainfall. The Atlantic salmon runs in these rivers are now extinct.

Atlantic salmon stocks in rivers in the pH range of 4.7 to 5.0 are markedly reduced. Angling records indicate a steady decline since about 1954 (see Cooley 1986, fig. 8). In those rivers where pH levels are still greater than 5.0, there has been no significant trend in angling records over the past 45 years, and juvenile salmon are still present at normal densities. The effects of surface water acidity on salmon are summarized in Table 2.

TABLE 2. Acid rain impacts on Nova Scotia rivers.

pH Category	Impact	No. of rivers affected
less than 4.7	No natural salmon reproduction	9
4.7–5.0	Some mortalities likely (30% mortality of early feeding fry at pH 5.0 (Farmer et al. 1980)	13
5.1–5.4	Fisheries threatened	9
more than 5.4	No immediate acidification threat	All other N.S. rivers

SOURCE: Watt (1981).

A Simple Economic Model

The operation of a fishery is frequently portrayed economically in terms of a demand-supply model. Copes (1972) and Copes and Knetsch (1981) used this approach in analyzing optimal resource utilization. The conventional situation is shown in Fig. 2. The demand for fish, assumed to be less than perfectly elastic, is represented by DD. The supply curve, S, shows the average (opportunity) cost per unit at different output levels. Average costs rise as output increases up to C. Output level C is the maximum sustainable yield. Attempts to increase fishing effort beyond the level associated with C actually reduces fishing output and increases cost per unit

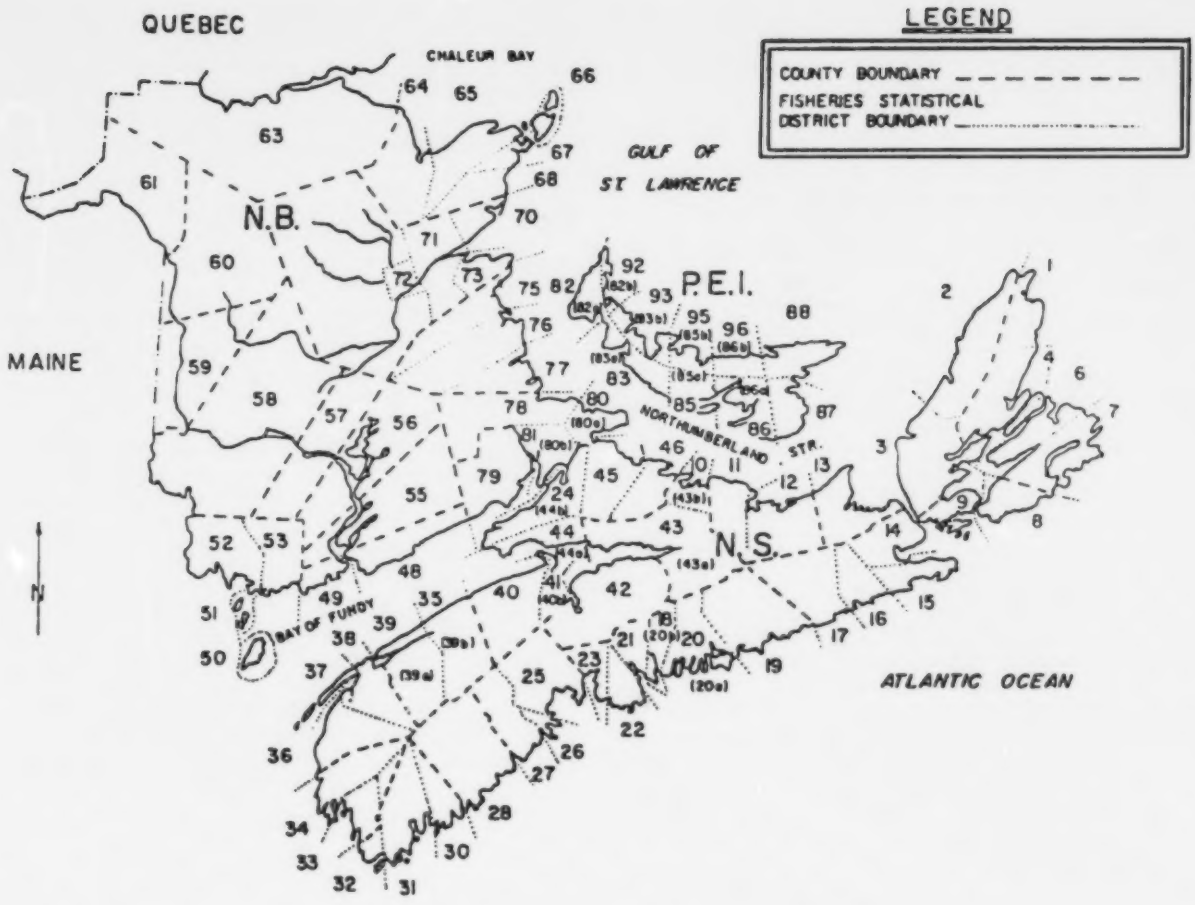

FIG. 1. DFO fishing districts of the Maritimes (Source: DFO, Redbook).

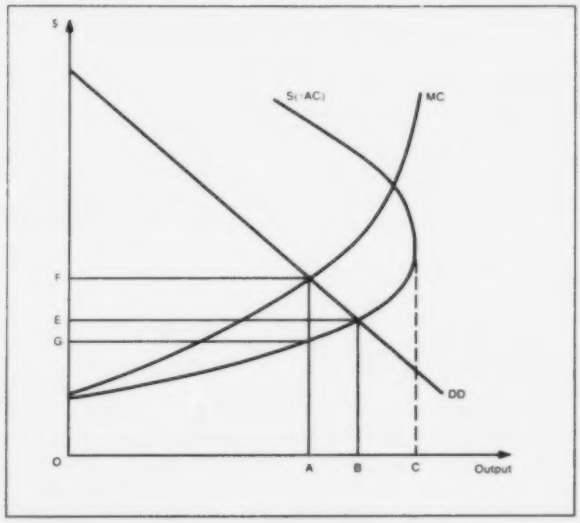

FIG. 2. Conventional model of a fishery.

output. The marginal cost per unit of output is shown by taking a marginal curve, labelled MC, to the supply curve.

In an open-access competitive fishery, the equilibrium fishing output level will be OB. The corresponding unit cost, OE, will be equal to the equilibrium market price. Copes and Knetsch (1981) show that the socially optimal fishing output level is OA where marginal cost equals the market price, OF. Average cost at output OA is OG, which is less than the market price.

The situation shown in Fig. 2 must be modified in order to represent appropriately the commercial salmon fishery in Nova Scotia. First, as noted previously, the Atlantic salmon fishery is not an open-access fishery. Only licensed fishermen can participate. Furthermore, fishing effort is constrained in several ways, such as:

a) only selected types of fishing traps are permitted;

b) the location of the gear is specified for the fishermen by DFO;

c) net mesh size is controlled; and

d) the length of the fishing season is adjusted according to estimates of the condition of the salmon stocks.

The intention of restricting effort is, of course, to ensure that output falls below the open access output level (and, therefore, below the maximum sustainable yield). For our purposes, the combined effect of the various restrictions on salmon fishing effort will be assumed to achieve the economically optimum output. Whether this is empirically true remains to be demonstrated.

Second, unlike many fisheries where the fishermen are mobile and pursue the fish stocks to wherever the latter are

located, within the limits permitted by fishing regulations, commercial salmon fishermen set their gear in a fixed location to wait for the fish (this is not strictly true for the drift net fishermen, but they account for only a small proportion of the total catch). The upshot is that once the salmon fishing gear is deployed, the level of fishing effort is largely determined. Some variation in labour time may occur according to the amount of fish caught and how much net cleaning is required. To put it differently, fixed costs dominate the cost structure for a salmon fisherman. Variable costs per unit are relatively small.

Third, the fixed characteristics of the salmon gear implies further that the level of the salmon catch is biologically determined during any given period of time. Once they set out their gear, fishermen are not able to increase their level of effort in order to achieve some desired level of output.

To incorporate these factors into the assumptions of the model involves first showing the supply of salmon per time period as perfectly inelastic at some output level. Considering the effort restrictions under which the fishery operates, if all goes well, the harvest level will be equal to the economic optimum. However, considering the year-to-year uncertainties introduced by the interception of Nova Scotia salmon off Greenland and off Newfoundland, and the unpredictable effects of climatic variations and weather conditions from year to year, the actual catch may vary considerably for any given level of effort. For simplicity, we assume that the harvest is in fact at the economically optimum level as determined by the intersections of the marginal cost and the market demand curve. This is shown by the vertical line at output OB in Fig. 3.

With a supply of salmon of OB, the competitive equilibrium market price will be OD, resulting in a market revenue of OBAD. The costs incurred by fishermen may exceed or fall short of this revenue. Assume that the average cost per salmon for an output OB is BE. Total costs are therefore OBEC. If the salmon fishery is characterized by a relatively high proportion of fixed costs per period and the average variable cost is constant with regard to the range of output, the average total cost can be represented by the curve AC in Fig. 3. AC is shown with a backward-bending portion to show that both economic and biological overexploitation are possible. However, we will only consider output levels up to and including the economic optimum. At output level OB, the area CEAD represents the resource rent accruing to the commercial salmon fishermen.

Assessing the Economic Cost of Acid Rain

The physical effects of acid rain on the stocks of Atlantic salmon in Nova Scotia were outlined previously. The main effect appears to be a reduced pH level in mainland Nova Scotia rivers flowing into the Atlantic Ocean. Some of these rivers no longer support any salmon stocks, while the carrying capacity of others has been seriously reduced. The overall outcome of acid rain appears to be a reduction in the stocks of Nova Scotia Atlantic salmon. Any reduction in the level of stocks will in turn lead to a reduction in the level of commercial Atlantic salmon catches. Conceptually, the economic impact of acid rain on the commercial fishery is demonstrated in Fig. 4.

To start, suppose that the restriction on commercial salmon fishing effort and the prevailing biological and weather conditions result in a catch of OA. With the assumed market demand curve, a market price of OD will prevail in equilibrium. The average cost at output level OA is given by OC. In terms of the numbered areas shown on Fig. 4, the total cost of harvesting OA is represented by (7 + 8). Total market revenue is given by (4 + 5 + 6 + 7 + 8). Resource rent, taken as the difference between market revenue and the opportunity cost of the resources employed to catch OA, is (4 + 5 + 6). Ordinary consumers' surplus is the usual triangular area (1 + 2 + 3). The sum of consumers' surplus and resource rent measures the net social surplus for a given catch level.

Suppose now that acid rain is introduced into the model and that other factors such as the restrictions on effort, the climate and weather, and the interception rates for Nova Scotia stocks off Newfoundland and Greenland remain unchanged. Because acid rain leads to a reduction in the

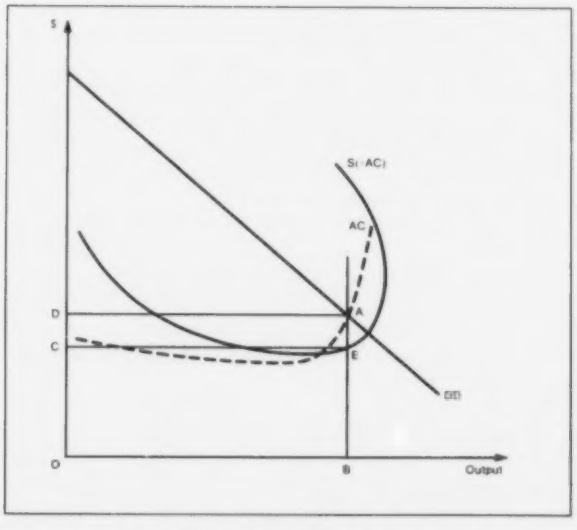

FIG. 3. Conceptual model of Atlantic salmon fishery in Nova Scotia.

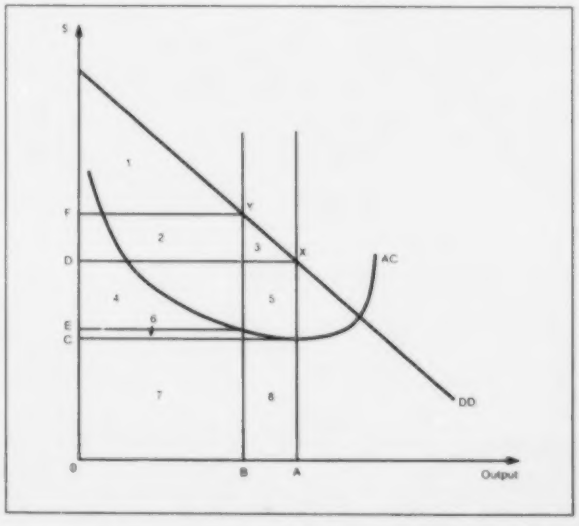

FIG. 4. Impact of acid rain on the Nova Scotia Atlantic salmon fishery.

stocks, the rate of catch of Atlantic salmon will be reduced to a level such as OB. Fishermen continue to make the same commitment of gear to the salmon fishery. There will be a small reduction in labour time associated with the reduced catch. The implied adjustment in costs is reflected in the AC curve. Assuming no change in the market demand for salmon, the new equilibrium will be at Y with a market price of OF. In this new situation, total market revenue is (2+4+6+7) and total market costs are (6+7). Hence, resource rent is now (2+4). Consumers' surplus is reduced to the triangular area (1).

The change in the net social surplus is measured by the area (3+5+6). Assuming that the pre-acid rain output level was at the optimal level, the lower post-acid rain output level is associated with a definite reduction in the net social surplus. Note that area (3) represents a loss in consumers' surplus, while areas (5) and (6) were previously included in resource rent. Area (2), which was previously part of the consumers' surplus, has now been redistributed to become part of the resource rent.

Empirical Issues and Requirements

To estimate the apparent loss in economic value in the Atlantic salmon fishery in Nova Scotia requires knowledge of the demand curve, the average cost curve and the shift in vertical supply curve caused by acid rain. These and other issues can be classified as either demand-side or supply-side issues.

Demand Side:

a) The theoretical model shows that the economic impact of acid rain is a reduction in salmon fishing output and an increase in the market price. The size of the price increase depends on the price elasticity of demand and hence is an empirical issue. An estimation of the demand curve is, therefore, required.

b) Catches by Nova Scotia commercial salmon fishermen tend to be small and highly variable from year to year. Processors and distributors find the low volume and the unpredictability of the Nova Scotia catch unsuitable to satisfy their markets. Consequently, much of the Atlantic salmon consumed in Nova Scotia comes from Newfoundland. Some industry people feel the figure could be in the 80–90% range. This situation may have significant implications for the demand for locally caught Atlantic salmon and requires further investigation.

c) Preliminary investigations suggest that Nova Scotia commercial fishermen sell their Atlantic salmon catch:

- to local residents in their immediate area;
- to local hotels, motels, restaurants and stores;
- to small local processors, some of whom sell the fish directly to their own employees; and
- to themselves.

The mixed destinations for their fish means the fishermen face a combined direct consumer demand-derived demand curve for Atlantic salmon. This may present some theoretical and empirical interpretation problems.

d) The official value and quantity of catch statistics are based on a variety of sources. The quantity of salmon caught commercially is reported on Purchase Slips submitted by processors. Supplementary Purchase Slips, which are meant to capture fish not reported on Purchase Slips, are submitted by DFO Fisheries Officers. Finally, since 1980, commercial salmon fishermen in Nova Scotia began keeping log books in which they record their catches. These sources are blended and reconciled to produce the officially reported catch. The value of the catch is based on an averaging of the selling prices recorded on the Purchase Slips and the Supplementary Purchase Slips. Where no price information is available for some of the reported catch, apparently the average reported value is assumed to apply. It appears that a thorough review of the catch and value reporting methods for the Atlantic salmon is necessary to insure the validity of any empirical estimates attempted.

Supply Side

a) The cost structure for commercial Atlantic salmon fishermen hypothesized in this paper consists of a high fixed cost component combined with a small, constant average variable cost. The AC curve shown in Fig. 3 and 4 reflects this hypothesis. The empirical nature of the cost structure needs to be determined before any estimates of the economic cost of acid rain are attempted.

b) The evidence to date suggests a definite link between acid rain and salmon stocks, but the empirical nature of that relationship has yet to be demonstrated. A quantitative estimate will be required in order to establish the size of the shift of the vertical supply curves shown in Fig. 3 and 4. Among the information requirements are the salmon rivers affected by acid rain, the level of stock reduction that has occurred, and the ratio or elasticity relating stock size to commercial salmon catch. The first of these items appears to be fairly well-known, but the second and third will require additional study.

c) Victor and Burrell (1981) point out that a range of industry responses to acid rain are possible, including:

- the elimination of some fishermen from the industry;
- reduced expenditures on equipment by some fishermen in response to a lower return from fishing effort;
- increased expenditures on equipment by some fishermen to compensate for a reduced catch per unit of effort;
- changes in the species mix sought by commercial fishermen;
- concentration of fishing effort in areas less affected by acid rain; and
- reduced recruitment of new fishermen into the industry.

Starting with the last item, the current licensing regulations prevent any new entrants to the commercial Atlantic salmon fishery. Concentration of effort in areas affected by acidification is possible by default, that is, fishing will occur in those areas and not elsewhere. Relocation of effort, however, is not permitted by the current salmon licensing regulations. Fishing regulations also make it very difficult for fishermen to shift their effort from salmon to other species. That some fishermen will decide to stop fishing for salmon because of acid rain is possible, although presumably this would be a last-ditch decision, since salmon fishermen are required to fish every year in order to retain their license. Whether salmon fishermen will increase or decrease their equipment-related expenditures requires further study. Given the tendency for salmon catches to fluctuate sharply from one year to the next, it may be possible to develop a relationship between catch levels and equipment expenditure which can be generalized to the acid rain situation. However, since fishermen expect catch levels to vary from one year to the

next, any change in behaviour attributable to increased acid rain may be delayed for several years.

d) The relationship between catch and effort is related to points raised in (c). It also bears on the nature of the cost function discussed in (a). The key issue appears to be what variables influence a fisherman's decision to commit a certain level of effort to the salmon fishery, and how that effort translates into an associated cost. Intensive interviews with a wide range of fishermen may be needed to shed further light on the issue.

Preliminary Empirical Findings

a) An attempt was made to estimate a demand curve for Atlantic salmon in Nova Scotia. The formulation tested was an inverse demand curve with price specified as a function of the estimated catch in Nova Scotia, real average per capita provincial income and commercial salmon catch in Newfoundland. The latter variable was included to reflect the apparently large proportion of Nova Scotia salmon consumption served by Newfoundland salmon. Newfoundland landings were used as a proxy for Nova Scotia consumption of Newfoundland salmon for which no data could be found. Annual data were used for all variables. Both linear and log-linear versions for the demand curve were tested. None of the results were statistically significant. Several hypotheses have been advanced to explain the poor results. None has emerged as the clear winner, but two deserve to be noted:

— the Nova Scotia salmon market is heavily influenced by the availability of Newfoundland salmon but the available data do not capture this relationship; and

— the official price and quantity data do not really measure what is happening in the market because too much Nova Scotia salmon is sold directly into local hands and little information exists on the nature of the transactions.

b) To establish a better understanding of the commercial fishery for Atlantic salmon in Nova Scotia, a survey of 15 randomly selected commercial fishermen was undertaken. By gear type, there were eight trap fishermen, five gillnetters, and two drift net fishermen. This split was chosen to reflect the approximate distribution of effort by gear type for all salmon fishermen.

On the demand side, the results were revealing. As shown in Table 3, more than one-half of the fishermen sold salmon directly to consumers. Six of the 15 kept some or all of their catch for their own consumption. Only two fishermen indicated that they sold to local processors. These results confirmed the view that many interested observers have expressed concerning direct sale to consumers.

TABLE 3. Number of fishermen selling their catch to selected buyers (n = 15).

Sold to	Number
Consumer (directly)	8
Processor	2
Retailer (Hotel, restaurants, etc.)	4
Keep Some or All	6

SOURCE: Gardner Pinfold Consulting Economists Limited.

TABLE 4. Estimated revenue and cost for a sample of 15 Nova Scotia commercial salmon fishermen.

	Average	Approximate Range
Revenue	$2,275	$60–9,000
Cost		
Operating	390	25–1,100
Labour	1,590	220–3,400
Capital	705	90–3,900
Surplus	(410)	(3,000)–2,300

SOURCE: Gardner Pinfold Consulting Economists Limited.

Two problems arise from this market behaviour. First, the problem mentioned previously concerning interpretation of the demand curve facing commercial salmon fishermen in Nova Scotia is a real one. Apparently, the demand curve is a mixed consumer-derived demand curve. Second, the fact that a significant portion of the Nova Scotia salmon catch is disposed of through channels not captured by the DFO purchase slip system raises some problems as to what the official data actually mean. This issue is being actively investigated.

c) Data on catch, revenue and costs were collected from the 15 fisheries in the sample. To preserve the confidentiality of the individual fisherman's information, only average values and ranges are reported in Table 4. As the figures show, both revenues and costs vary widely about their averages. The revenue figures are based on the number of fish caught by each fisherman and the reported sale price. Where a fisherman consumed some of the salmon directly, these were valued at the price received for any that were sold or at the average price for the sample, $7.70 per kilogram ($3.50 per pound). Surprisingly, prices were at or very close to the $7.70 figure across the sample.

The costs are calculated on an opportunity–cost basis. For operating costs like fuel, the market price was accepted as a reasonable measure of opportunity cost. Labour costs were calculated by multiplying the number of hours devoted to salmon fishing by the minimum wage. Labour hours were estimated according to the information provided by the fishermen in a detailed review of a typical salmon fishing day for each of them. Where they were active in more than one fishery simultaneously, care was taken to apportion their time. Alternative wage rates higher than the minimum wage were considered such as the fish plant worker's average wage and the industrial composite for primary sector industries. For many of the fishermen, readily available alternative employment was lacking, so we chose to use the minimum wage rate as a reasonable proxy to the social opportunity cost of labour.

Capital cost was also calculated on an opportunity–cost basis, but this is probably the weakest of the three cost estimates. Capital was defined to include boats, nets and other gear. The quality of information the fishermen could provide on their capital varied considerably from person to person. For our estimate of capital cost, we adjusted each fisherman's apparent investment to a common base, using a combination of replacement cost, historical cost and depreciation information. The result was a blended estimate of the value of invested capital in 1983, to which the average 1983 interest rate for Government of Canada 10-year-plus bonds was applied to estimate the capital rental rate. Care

was taken to apportion capital where items such as boats were used in more than one fishery. Even so, the estimates used may still be high considering that some of the gear has apparently no alternative use.

On average, the 15 fishermen did not cover the opportunity costs of fishing for Atlantic salmon. However, the wide ranges about the average revenue and cost values indicate that some fishermen were able to earn a surplus over their estimated opportunity costs. It should be noted that 1983 is regarded as a poor year in the Nova Scotia Atlantic salmon fishery. According to the fishermen, for no increase in effort or at most a very small increase, and consequently for a very small increase in costs, their catch and revenue would increase significantly in a good salmon year. According to our understanding, the fishermen expect the fishery to be good in some years and bad in others. Since their costs are relatively low and they can remain in the salmon fishery for a modest investment, they are prepared to wait for the good years.

Other factors may influence the fishermen's attitude toward the salmon fishery. For one thing, they do not calculate their costs on an opportunity–cost basis. Many of the fishermen will receive a net return over their cash costs, which, while it is small, is nevertheless positive. For others, salmon fishing is part of their way of life. They would continue to fish because that is what they have always done. Also, for some fishermen, the salmon is a prize fish which apparently takes on a value over and above its market price. The last two items point in the direction of the worker satisfaction bonus, a concept which Anderson (1980) has suggested is relevant to resource allocation decisions by fishermen.

Summary

This paper has presented an overview of the commercial Atlantic salmon fishery in Nova Scotia. The number of licensed fishermen is steadily dropping, partly as a result of an attrition policy by DFO (currently there are 225 licensed fishermen). Acid rain, so far, appears to have affected mainly rivers flowing across mainland Nova Scotia into the Atlantic Ocean by lowering the pH level to such an extent that some rivers no longer support a salmon population. Others are experiencing pH levels in the 4.7 to 5.0 range, which threatens existing salmon stocks.

A model of the fishery was developed with two special features. The supply of salmon in any one year is regarded as biologically determined. This is expressed as a completely inelastic supply curve at a given output level. The cost of harvesting salmon is assumed to consist of a large fixed-cost component. An average cost curve is introduced to help derive the total cost of harvesting different levels of output. The net social surplus generated by the fishery is shown to be a combination of consumers' surplus and resource rent. When acid rain is introduced into the model, it causes the inelastic supply curve to shift to the left, indicating a lower output of fish, other things being equal. The economic cost of acid rain is derived as the change in the value of the net social surplus, which is the combined effect of the change in consumers' surplus and the change in resource rent.

The empirical issues and data requirements are expressed in terms of demand and supply side factors. The need to estimate the demand curve, the mixed consumer-derived curve nature of the demand for Atlantic salmon in Nova Scotia, the large proportion of the market served by Newfoundland salmon, questions concerning the official catch and value statistics are the main demand side issues. The confirmation of the cost of the commercial fishery and the establishment of a quantitative link between acid rain, salmon stocks and commercial catch emerge as important supply side issues.

Finally, some preliminary results from a survey of 15 commercial salmon fishermen establish clearly that these fishermen sell their catch to a wide variety of buyers, including households, hotels, restaurants, stores, processors and themselves. Interpreting the salmon demand curve and the official salmon data requires further work. The postulated cost curve with a large fixed cost component appears to be a correct interpretation of the commercial salmon fishermen's cost structure according to the interview results. The revenue and cost estimates show that on average the commercial salmon fishermen did not cover the estimated opportunity cost of salmon fishing in 1983. However, some individual salmon fishermen in the sample did earn a surplus in excess of their opportunity costs. In a good year, which 1983 was not, the fishermen would expect to enjoy a substantial increase in catch and revenue with only a modest increase in costs, suggesting that the fishery could generate a surplus, that is, a resource rent, in excess of opportunity cost. Additional work is required to check the estimates of opportunity cost, to relate these results to the acid rain issue and to determine the relevance of the fishermen's attitude toward the fishery, including the worker's satisfaction bonus, before final conclusions can be drawn.

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Data Availability and Requirements for Acid Rain Impact Evaluation

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Abstract

The author served as the chairman in a discussion of the data requirements and availability for the various socio-economic models presented at the seminar. This paper is a summary of the discussion.

A plan of action for 84/85 was developed for the Department of Fisheries and Oceans. This plan examined alternative data collection and analysis techniques and recommended a preferred course of action for each of the various geographical regions of Eastern Canada impacted by acid rain. The three analytical methodologies recommended were discussed at the seminar; namely, contingent value method, hedonic value method, and the Talhelm travel cost method.

The preliminary travel cost study undertaken by Victor & Burrell for the Muskoka–Haliburton recreational fishery utilized diverse sources of existing information. These data were less than satisfactory from a statistical and methodological point of view. Consequently the approach recommended as most cost-effective in the plan was to intercept fishermen at highway locations leading to and from fishing sites and areas.

This recommendation was supported by the experts in attendance. Existing data sources were concluded to provide a frame of reference for designing an angler survey and for crosschecking and extrapolating the results. In addition, a broader survey of the general public was recommended for the contingent value technique to obtain the existence and option values of non-anglers and the former for anglers.

Several points were raised with respect to implementing these socio-economic techniques and integrating them with biophysical dose–response models. In particular, secondary impacts due to anglers shifting their activity and overfishing and explicit recognition of the high degree of uncertainty in the physical impact estimates were seen as being of primary importance.

Finally, estimates of the value of non-marketed goods are seen as being theoretical by some since no actual monetary transaction takes place. The need for relating these estimates to entrance fees actually paid was emphasized. The unique tenure system in Quebec offers the opportunity to compare entrance fees paid to estimated consumer surplus values.

Résumé

L'auteur a présidé une discussion sur les données disponibles et requises pour divers modèles socio-économiques examinés au cours du séminaire. Le présent document constitue un résumé de la discussion.

Un plan d'action pour l'année 1984–1985 a été mis au point pour le ministère des Pêches et des Océans. Ce plan proposait diverses méthodes de cueillette et d'analyse des données et recommandait une marche à suivre pour chacune des régions géographiques de l'est du Canada affectée par les pluies acides. Les trois méthodes d'analyse recommandées (valeur des éventualités, valeur hédoniste, méthode Talhelm du coût de déplacement) ont été examinées lors du séminaire.

L'étude préliminaire du coût de déplacement réalisée par Victor & Burrell sur la pêche sportive dans la région Muskoka–Haliburton a utilisé des données existantes. Celles-ci n'étaient pas satisfaisantes, ni du point de vue statistique, ni du point de vue méthodologique. L'approche considérée comme la plus rentable dans le plan était celle qui recommandait d'arrêter au passage les pêcheurs sur les routes lorsqu'ils se rendaient à leurs lieux de pêche ou qu'ils en revenaient.

Cette recommandation a été appuyée par les spécialistes présents. Il a été établi que les données déjà disponibles pouvaient servir de point de départ pour préparer un sondage qui serait réalisé auprès de pêcheurs à la ligne et qu'elles pourraient être utilisées pour vérifier les résultats et faire des extrapolations. Par ailleurs, il a été recommandé d'étendre le sondage à l'ensemble de la population pour obtenir les valeurs d'existence et d'option pour ceux qui ne pratiquent pas la pêche à la ligne et pour ceux qui le font.

Plusieurs points ont été soulevés quant à l'utilisation de ces méthodes socio-économiques et à leur intégration aux modèles biophysiques dose-effet. Les effets secondaires attribuables au changement des activités des pêcheurs à la ligne et à la surpêche pratiquée par ces derniers ainsi que l'imprécision des évaluations des effets d'ordre physique sont deux eléments d'importance capitale.

Finalement, l'estimation de la valeur de produits non commercialisés est considérée par certains comme purement théorique puisque aucune transaction financière n'a véritablement eu lieu. L'accent est mis sur la nécessité de lier ces estimations aux droits d'entrée présentement exigés. Le système de baux en vigueur au Québec permet de comparer les droits d'entrée payés aux estimations concernant ce que les gens consentiraient à payer.

The request to serve as chairman of this discussion was made shortly before the session began. My participation in previous socio-economic and biological studies of acid rain (Victor & Burrell et al. 1981 and 1982; Hough, Stansbury & Michalski Ltd. and JE Hanna Associates Inc. 1982) has familiarized me with both socio-economic and biophysical methodologies available to implement them. In particular, my role in preparing the 1983/84 action plan for the Department of Fisheries and Oceans (Victor & Burrell 1983) forced explicit evaluation of the strengths and limitations of a wide range of socio-economic techniques including those discussed at this meeting and available data. We also considered what data might feasibly be collected. My training, however, is in biology and resource modelling. I suspect that relatively neutral background was the primary reason for being selected to lead this discussion.

My understanding of these techniques is basic and does not encompass all of the more subtle theoretical aspects; the

experts present are asked to consider these in discussing the requirements of the various approaches. I do, however, have an appreciation of angling and fisheries data sources both provincially and federally, the nature of the information recorded, the survey methods and the comprehensiveness of the coverage. By combining this information on the resource base and users with your understanding of the requirements of the economic techniques, we hope to devise a practical strategy for estimating the economic value of acid rain damages to fisheries in Canada.

Specifically, three issues need to be considered:

i) Definition of data requirements for each methodology recommended.
ii) Identification of potential existing data sources and the specificity and form of the information available.
iii) Additional original data required and preferred collection technique(s).

Three economic methodologies have been the focus of the discussion, namely contingent value, hedonic and Talhelm travel cost. The three issues need to be considered in relation to these methods.

Jack Knetsch raised an important point in his presentation relative to the contingent value method; that is, it may be important to differentiate between anglers and non-anglers. The consumer surplus from using the fishery is estimated by the other two methods but an additional existence value is not included; this can be accomplished by means of a contingent value analysis.

Table 1 shows the data categories needed to operate the models. In the second column is a list of sources that might potentially be used to deal with each of these data categories. The last three columns deal with the economic models, namely, the contingent value, hedonic value and Talhelm travel cost. Each of the experts present will be asked to consider as we go through the information, its necessity and the adequacy of the various sources.

As a point of clarification in reviewing this table, consider whether the data is required on an individual angler basis or whether a series of data sets can be used together. For ex-

TABLE 1. Data requirements to formulate models. (Discussion results)

	Data category	Sources	Economic Models[a]		
			Contingent Value	Hedonic Value	Talhelm Travel-Cost
1.	Travel Patterns — origin/destination — purpose of trip	National Sport Fishing Survey (NSFS) provincial creel censuses angling surveys	Yes	Yes	Yes
2.	Transport Costs — variable costs	Statistics Canada and provincial travel surveys	0	Yes	Yes
3.	Travel Time Costs — how to estimate not yet discussed		0	I	Ii
4.	Angling-Related Expenditures	NSFS, Statistics Canada and provincial consumer expenditures surveys	I	I	Ii
5.	Angling Use (by species)				
	— time spent fishing	NSFS	Ii	I	Ii
	— expected catch per unit effort (CUE)	Angling Survey	NoD	I	I
	— actual CUE	NSFS, creel censuses, angling survey	NoD	I	I
	— fishing sites	NSFS, angling survey	NoD	Yes	Yes
6.	Supply — characteristics of site	DFO and provincial lake surveys, topographical maps and aerial photos, creel census	NoD	NoD	Yes
7.	Contingent Value	Angler Survey/National Survey	Yes	Optional	Optional
8.	Socio-Economic Profile — income, occupation, age, sex		I	I	I (income only) NoD (others)

[a] Legend: Yes = data needed and sources indicated are adequate; NoD = data not needed; O = undecided — may or may not need the data; I = data needed for individuals; Ii = data needed for a subset of individuals.

ample, the work reported by Peter Victor and Dan Talhelm made use of existing data. A problem they discussed is that the information came from a diverse range of sources and was based on totally independent samples. In other words, the same individual is not likely represented in each one of the source data bases; instead some assumptions about uniform variations among sample populations were made.

1. Travel Patterns

The first data category is travel patterns, and there are two subsets. There is origin–destination information, and purpose of trip information. Origin and destination refers to where the anglers start from, where they go to fish and the purpose of the trip (i.e., whether the primary purpose was angling or not). As a result of the pilot test of the Talhelm travel cost method in Ontario, there are several known data sources. For example the National Sport Fishing Survey (NSFS) is conducted across Canada. The data collected is on a provincial basis through the coordination of the federal government. The information available includes for each angler the number of fishing trips made, where they fished, and what was caught. One point to note is that the anglers are also asked about expenditures and other information related to other categories in Table 1. One of the problems faced is that the information is not machine-readable. While anglers are asked which lake or which fishing site they visited, the information hasn't been compiled and analyzed on a lake-by-lake basis. It has been analyzed on a broad regional basis and according to the nearest town or major centre. To go to individual destinations, the information has to be put in a machine-readable form compiled on a lake-by-lake basis. A final point is the low sampling frequency relative to individual destinations. In our study of the Haliburton–Muskoka Lake of over 2000 lakes less than 10% were reported as fishing sites and reasonably sized samples were only available for a handful of these.

Provincial creel censuses are potential sources of information. There are two major limitations with these data. First, they generally are not designed to be representative of local fisheries. This was already mentioned about creel censuses. Creel censuses are usually carried out where there is the more intensive fishing pressure. It's not a statistically sound sample in terms of representing the fisheries of a region. The other problem with the provincial creel censuses is that angler's origin is often defined according to resident/non-resident. These origins are quite gross and don't deal specifically at the level of detail required to implement the travel cost and hedonic approaches.

The last source of data included is specially designed angling surveys for the purposes of the approaches being considered. These are new data; data that are not already available. The information that is needed certainly can be obtained through a new survey.

These are my views but I would like to confirm with you that these data are required and they could possibly be obtained from the sources indicated (see Table 1 for the discussion results on the data requirements for each model and data category).

2. Transport Costs

The next data category is transport costs, and specifically variable transport costs (e.g., gas, incremental wear on vehicle). These are the costs that are associated with vehicle operation to reach the site. This does not include expenditures that are incidentals (e.g., meals) but only transport costs. For information sources, there are two potential generic sources. First, Statistics Canada carries out a labour survey, which is conducted monthly. Periodically, they added on what is called a travel survey in which they ask people about their travel patterns. Actual costs associated with the trip are reported. Reasonably good *average* transport costs can be obtained. Another source in Ontario is the provincial Department of Transportation and Communications periodic surveys of people's travel patterns including costs of trip. These also provide average cost data.

3. Travel Time Costs

Professor Berczi made a point yesterday in his presentation about the need to develop a good method to estimate the value people assign to their time. I think there is a general agreement that travel time should be accounted for as a cost, but there hasn't been much discussion in terms of preferred estimating procedures. Two things need to be considered. First, what are the best estimation methods and secondly, what sources of data are available to quantify this cost?

Similar studies to those that Dan Talhelm referred to in Michigan (i.e., travel time matrices from origins to destinations) are available in a number of provinces. They are usually undertaken by provincial departments of highways and provide estimates of average times between origins and destinations. The times are based on average speeds for certain road types. Tom Pinfold referred in his presentation to the Halifax time budget study data in this context. We are always faced with how long you want to make questionnaires and it may be that these secondary sources are adequate to estimate travel times.

4. Angling-Related Expenditures

This data category includes direct expenditures related to angling (e.g., lures, bait, boat rental). Do you need this type of data on a trip-by-trip basis or can they be averaged across fishermen?

Some information is currently available. The National Sport Fishing Survey reports fishing expenditures, although not by trip. Statistics Canada also has consumer expenditure surveys that cover a wide range of expenditures including recreation. But no trip-by-trip data are reported.

5. Angling Use

There are four data subsets for angling use. One is the time spent fishing; another is the expected catch or the expected quality of experience; the next is the realized quality of experience; and finally the fishing sites visited where the activity took place while you were on that trip, including multiple destinations.

Many possible sources of data are available but, they don't report fishing activity by individual anglers. The National Sport Fishing Survey does have information on an individual basis; however, as already mentioned, limitation is that the small sample size for individual destinations. This is due to large numbers of fishing destinations available to anglers. This potential data source is likely not useful for this reason.

6. Supply

This category refers to the available supply of fishing experiences available to anglers. These are defined in terms of characteristics of each site. Data sources include provincial and federal lake and river surveys. These provide information in terms of fish species and the size of lake. Topographic maps and air photos can be used to determine numbers of cottages and lake access and size. Also creel censuses can be useful but they generally provide only spotty coverages. Is there a requirement for supply data that is collected individually from an angler survey or do you think the existing sources would be adequate for your purposes?

7. Contingent Value

The next category is contingent value. It is self explanatory; obviously a measure of willingness to pay or accept compensation is required for a contingent value survey. It is on an individual angler basis. Neither the hedonic or travel cost methods include existence and option values particularly for non-fishermen, so that these measures would be a useful supplement.

8. Socio-Economic Profile

Socio-economic profile includes income, occupation, age, sex, etc. These data are required in all cases for individual anglers.

Implementation

Once the basic socio-economic data are collected, two additional steps are required to estimate benefits: (i) dose–response functions, which are essentially biophysical aspects of spatial and temporal changes to available angling opportunities and experiences and (ii) the secondary impacts of angling use redistribution. The key point is that it is imperative that the fishing characteristics used in the economic models are related to changes caused by acid rain. For example, if the major impact of acid rain were predicted to be the reduction or complete removal of given fish species, then this species must be used as one of the characteristics defining various types of fishing opportunities (i.e., fishing supply).

One of the obvious areas that has already been discussed is catch. Clive Southey presented some interesting ideas on this subject yesterday in terms of consumer surplus in the recreational fishery. It is important that whatever parameter(s) used be a good representation of the value and that it also has a relationship to acid rain. Fish are one of the major (if not the major) characteristic impacted by acid rain. The biophysical response function must include both a spatial and temporal profile. Despite the fact that we heard some fairly definitive statements about the number of lakes that are going to be dead, the timeframe in which this will take place is critical from an economic perspective. Also the degree of uncertainty associated with these estimates is important in terms of making wise policy decisions.

Redistribution of angling use was indirectly raised by Clive Southey yesterday. Dose–response functions forecast direct effects of acid rain on certain characteristics of a fishery but there may be additional secondary impacts indicated by the redistribution of anglers. In other words, if you have a lake that no longer supports a certain quality of fishing, some anglers may quit fishing altogether but others may move to other sites. This redistribution has a ripple effect and in heavily fished areas, the secondary effects could be greater than the direct primary impacts. Congestion at other sites and reduced catch notes may result with further shifts in fishing experience. In effect, a new system equilibrium may result. This is partially a biological problem, but there are social and economic dimensions in terms of angler behaviour. These responses must be predicted if the full impact of acid rain is to be estimated. This is not as much a data issue as a methodological issue that should be kept in mind. Care must be used to integrate dose–response functions and secondary redistribution of use with attendant secondary impacts.

These three methods are designed to derive prices for non-marketed goods. One underlying assumption is that these prices represent the amount people would be willing to pay if, in fact, an entrance fee was to be placed on access to the resource. Or conversely, that people would accept to forfeit the right to fish. The question arises, are there any examples where entrance fees are actually paid for some of the resources and how do they compare to these estimated values? Two examples in Canada are available from which some inferences might be drawn.

The first example is New Brunswick salmon leases. Archie Tuomi has studied this example quite extensively. The outcome of these analyses was that there is a small number of transactions taking place at any one time and the selling prices do not represent a market value. There are often many other considerations included in the price other than direct cash exchange. As a result, this example may be of limited value in verifying our estimates.

The second example comes from Quebec. In Quebec you can own or lease water, whereas in many of the other provinces that is not the case, New Brunswick being another exception. There are approximately seven hundred tourist outfitters with a large clientele many of whom have exclusive access rights and who charge entrance fees. In addition, the provincial government operates its own tourist outfitting operation which also has exclusive rights to certain fishing and hunting areas. A fairly extensive area of Quebec, which is also susceptible to acid rain, is controlled by leased exclusive rights. It may be possible to apply in Quebec the hedonic and/or Talhelm travel cost approach and to compare the estimated price to the actual entrance fees charged as a basis for verification. This would increase the credibility of the value estimates of these non-marketed goods. The large number of cases in Quebec would allow the verification to be applied across a wide range of angling experiences as a means to test these relationships also.

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Ontario

In Ontario, the value of the sportfishery is in contention and there is much to be gained in solving the methodological issue. For the coming year 1984/85, there should be a concentration of effort on the Muskoka–Haliburton Region to utilize existing research and information as much as possible. Primary data to get a meaningful test of the three different models in this area should not exceed $100,000.

In the longer run, it would be ideal to utilize existing and regular data sources, such as creel censuses and the National Sportfishing Survey to capture the information necessary to feed these models.

Quebec

Unlike Ontario, previous acid rain economic valuation research had not been conducted for any region in Quebec. The problem is even more complex there than for Ontario. For example, biological research is spread throughout various locations of the Province. Thus, the most accessible location for data (including economic) would be the controlled harvesting zones (ZEC's) where reasonably specific data is monitored.

Both the Talhelm type model and the contingent valuation approach could be usefully applied in the province. A Talhelm travel study would require selection of one of the ZEC's and the collection of existing data from these. The contingent value approach could be conducted for the province in 1984/85 and integrated into a national survey.

Other Atlantic Provinces

A Talhelm study is currently being undertaken in Nova Scotia, and is expected to be available by the late fall. It would be desirable to examine the value of the recreational fishery as measured by lease-hold values in New Brunswick. It would also be useful to have a "willingness to pay" survey of both anglers and non-anglers this year. Finally, a native impacts study for the Atlantic region is necessary.

Ontario

En Ontario, la valeur de la pêche sportive est remise en question et il y a beaucoup à gagner à résoudre la question de la méthodologie. Pour la prochaine année 1984–1985, les efforts devraient être concentrés dans la région de Muskoka–Haliburton afin d'utiliser la recherche et l'information existantes dans toute la mesure du possible. Les données fondamentales nécessaires pour obtenir des résultats significatifs des trois différents modèles dans cette région ne doivent pas dépasser 100 000 $.

À plus long terme, l'idéal serait d'utiliser les sources existantes et régulières de données, comme le Relevé national sur la pêche sportive, pour recueillir l'information nécessaire pour alimenter les modèles.

Québec

Contrairement à l'Ontario, aucune recherche antérieure sur l'évaluation économique des pluies acides n'avait été effectuée au Québec. Le problème est même plus complexe au Québec qu'en Ontario. Par exemple, la recherche biologique est répartie à divers endroits dans la province. En conséquence, la source la plus accessible des données (y compris les renseignements économiques) seraient les zones d'exploitation contrôlée (ZEC) où des données raisonnablement précises sont recueillies.

Le modèle de type Talhelm et l'approche d'évaluation des éventualités pourraient être appliqués utilement dans la province. Une étude des déplacements de Talhelm nécessiterait la sélection d'une des ZEC et la collecte des données existantes à cet endroit. L'approche d'évaluation des éventualités pourrait être appliquée pour la province en 1984–1985 et intégrée dans un relevé national.

Autres provinces de l'Atlantique

Une étude de Talhelm, menée actuellement en Nouvelle-Écosse, devrait produire des résultats à la fin de l'automne. Il serait souhaitable d'examiner la valeur de la pêche récréative telle que mesurée par les valeurs de propriété louée à bail au Nouveau-Brunswick. Il serait également utile de réaliser, cette année, une enquête sur le «consentement à payer» parmi les pêcheurs à la ligne et ceux qui ne pratiquent pas cette activité. Enfin, une étude des impacts sur les Autochtones dans la région de l'Atlantique est nécessaire.

APPENDICES

Position of The Canadian Tourism Industry and The Canadian Coalition on Acid Rain on Acid Rain Control

Issued by:

Allied Boating Association of Canada
Canadian Coalition on Acid Rain
Ontario Federation of Anglers and Hunters
Northern Ontario Tourist Outfitters Assoc.
Resorts Ontario
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Tourism Ontario

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1. Introduction

The effects of acid rain are now appearing throughout the United States and Canada. The loss of fish from thousands of lakes and streams is the most obvious effect, but acid rain is taking its toll in other ways as well. Acid rain is leaching nutrients from forest soils while releasing toxic metals from the ground. Buildings and monuments are being eroded. And public health may be endangered. The U.S. National Academy of Sciences estimates that $5 billion or more in damage is done every year by acid rain in the eastern United States alone, while in Canada, the National Research Council has placed a minimum figure of $350–500 million on annual damage to buildings and property. Federal officials estimate that the sectors of the Canadian economy potentially at risk from acid rain in eastern Canada represent slightly more than 8% of the total Canadian GNP.

The cause of acid rain is pollution from the combustion of coal and other fossil fuels. In 1980, more than *50 million tons* of sulfur and nitrogen oxides were released over North America. Most of this pollution was emitted in the eastern United States, where there are extensive areas susceptible to acid rain. (see Fig. 1). Areas with thin or sandy soils and limited calcium for buffering (absorbing) acids are especially susceptible to acid rain damage.

While acidic rainfall was recorded in a few highly indus-

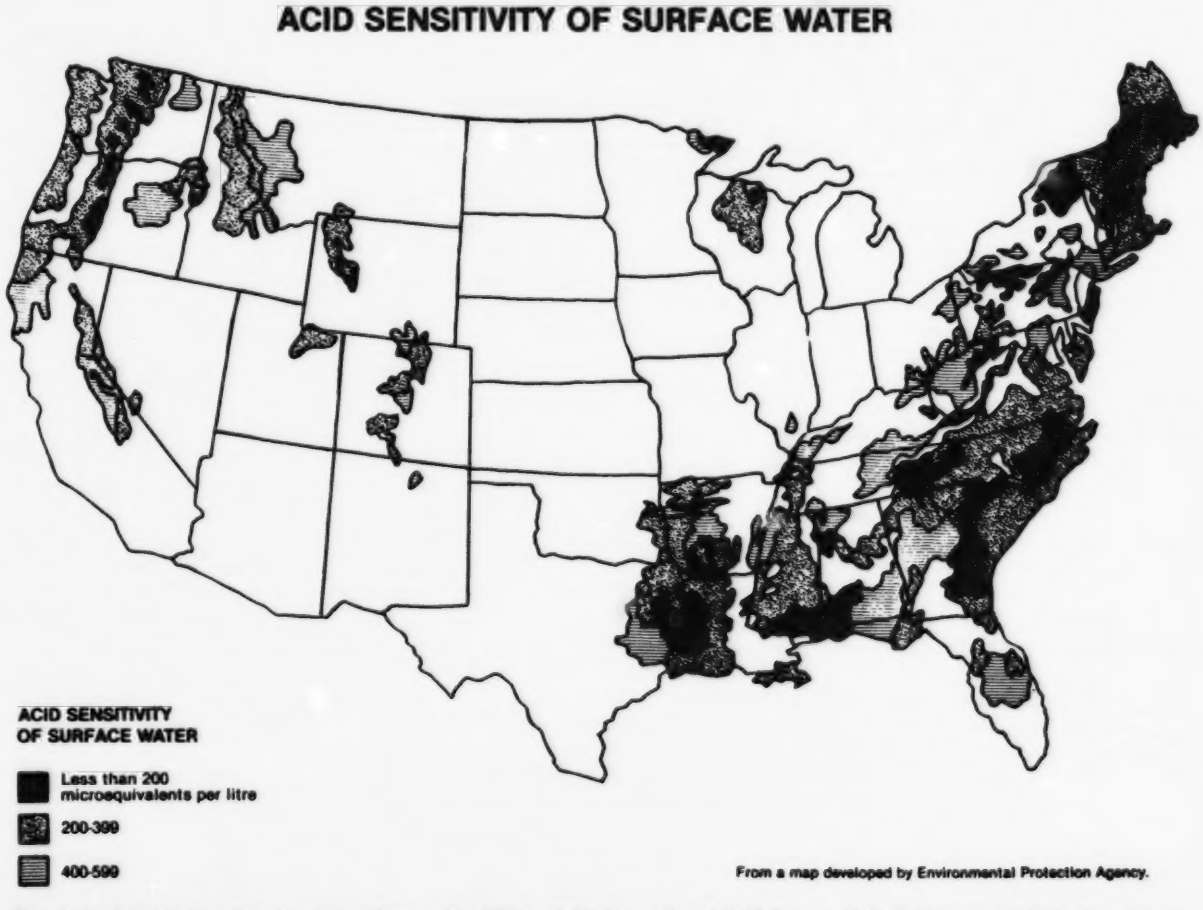

FIG. 1 Acid sensitivity of surface water (Prepared in 1983 by J. M. Omernik and C. F. Powers, U.S. Environmental Protection Agency, Corvallis Environmental Research Laboratory, Corvallis, OR 97333, USA).

trialized cities in the late 1800's and early 1900's, today's problem is on a continental scale. From 1950 to 1978, emissions of these pollutants from power plants in the eastern United States have *tripled* during the same period. In Canada the level of sulfur dioxide emissions in 1980 represents a 7.5% net increase over 1955 emissions.

The increase in pollution from power plants is compounded by the building of the taller and taller smokestacks. Some of the stacks built in the U.S. in the last decade are as tall as the Empire State Building; the stack at Inco Ltd.'s Sudbury, Ontario smelter is the world's tallest.

Sulphur and nitrogen oxides from power plants and industry are often transported hundreds of miles before being brought to earth as acid rain or snow, sleet, fog, or as dry particles.

2. The Problem

a) Rainfall over much of North America is abnormally acidic.

All rain is slightly acidic (around pH 5.6) due to naturally occurring carbonic acid. The rain falling over the eastern United States and Canada, however, and in pockets of the western United States, averages *30–40 times* more acidic than unpolluted rain (see Fig. 2).

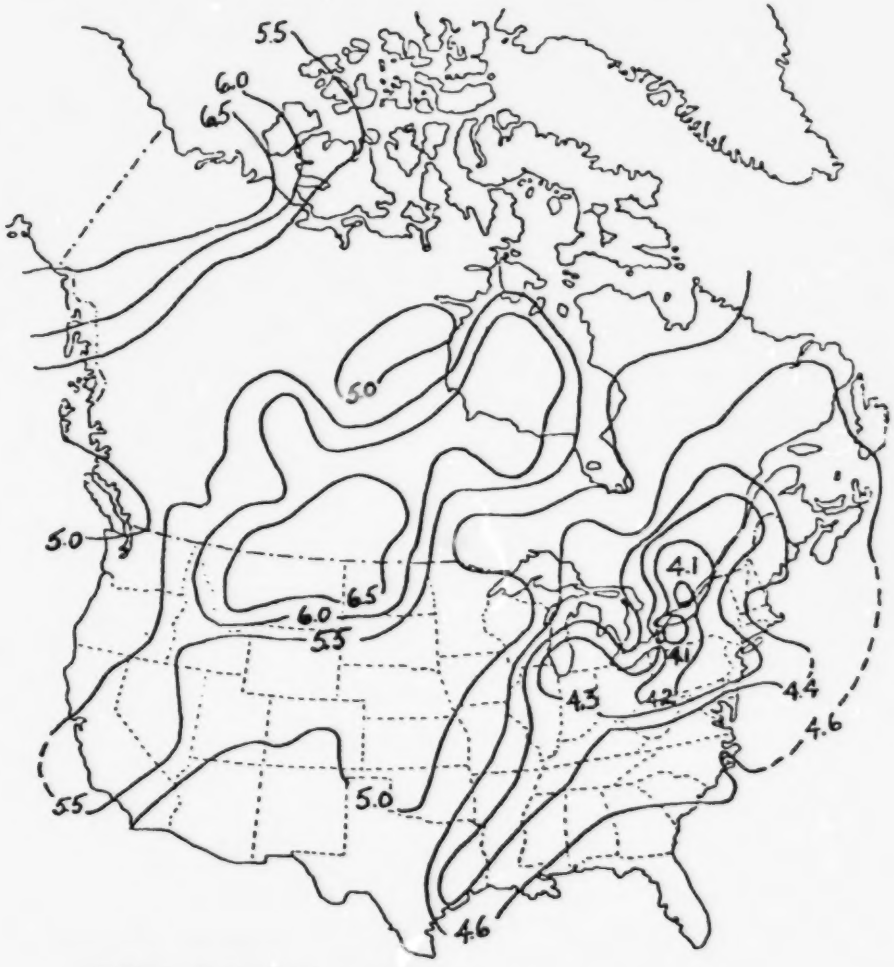

FIG. 2. Eastern average annual pH is 4.3, but some individual storms have measured as low as pH 1.5. Snowmelts can also increase the acidity dramatically. The pH of precipitation in certain western locations is significantly lower than indicated above.

— Rainfall in the east now averages pH 4.0 to 4.3. The record storm occurred in Wheeling, West Virginia, when the rain was as acidic as battery acid (pH 1.5).
— Rainfall over the west averages pH 4.2 to 5.5, while the midcontinent states average pH of 4.4 to 5.0. Acid fogs, usually more acidic than acid rain, range between pH 1.7 and 4.0 in the Los Angeles area.

Sulphur oxides contribute 70% of the acids in the East and 60% to 65% in the Rocky Mountain West. In California, nitrogen oxides contribute most of the acids.

b) Acid rain has already caused extensive damage to lakes and streams.

Thousands of lakes and streams across the United States and Canada have been acidified to the point where fish can no longer live in them. Tens of thousands more are threatened. The National Academy of Sciences warned in 1981 that unless acid rain were controlled, the number of affected lakes would *double by 1990* [1].
— Fish in 212 Adirondack lakes have already been lost. The Office of Technology Assessment (OTA) estimates that more than *9000 lakes* and *60 000 miles of streams* in the eastern United States are threatened by acid rain [2, 3].
— In Ontario, 1400 lakes and ponds have already succumbed to acid rain and the Ontario government estimates that another 48 000 are threatened with extinction [4].
— In Minnesota, 15% of the lakes have already been damaged and 2600 lakes are now at the critical state [5].
— In Pennsylvania, the state government has found that 36 of 40 high mountain streams surveyed over the last 20 years have lost a significant part of the ability to buffer acidity and 20 have become more acidic [6].

U.S. States Vulnerable to, or Already Damaged by Acid Rain

Alabama	New Jersey
Arkansas	New Hampshire
California	New York
Colorado	North Carolina
Connecticut	Oregon
Delaware	Pennsylvania
Florida	Rhode Island
Georgia	South Carolina
Idaho	Tennessee
Kentucky	Texas
Louisiana	Utah
Maine	Vermont
Maryland	Virginia
Massachusetts	Washington
Minnesota	West Virginia
Mississippi	Wisconsin
Nevada	Wyoming

Canadian Provinces Vulnerable to, or Already Damaged by Acid Rain

British Columbia	Quebec
Saskatchewan	Nova Scotia
Ontario	New Brunswick
	Newfoundland

The problem is not limited to the Northeast.
— An EPA report and map indicate that the vast part of the southeastern United States is vulnerable to serious acid rain damage due to limited buffering capacity (Fig. 1).
— New studies show that lakes in the western United States, particularly Colorado and Washington, are being damaged by acid rain [7].
— According to surveys by EPA and OTA, lakes and streams in 34 states are either vulnerable to or have already been damaged by acid rain [8].
— In Nova Scotia, acidification has destroyed salmon populations in eight rivers, and seriously threatens 21 more [9].
— Nearly all of Quebec's surface waters are believed to be highly sensitive to acidification, and monitoring of the Laurentides Park has shown rainfall in the area to be constantly acidic [10].

c) The effects of acid rain on forests could be far more extensive and irreversible than the damage to lakes and streams.

Forests in the eastern United States, Canada, and Europe are suffering from stunted growth and "die-back." Most of the usual causes such as disease, insects, population cycles, and climate have been ruled out. Evidence that acid rain is causing forest damage is accumulating at a rapid rate.
— In Vermont, acid rain is the primary suspect in the death of red spruce trees on high altitude slopes. Effects similar to those observed in the red spruce have appeared in other tree species: loblolly, shortleaf, and pitchpine [11, 12].
— In West Germany, extensive forest damage from acid rain prompted the government to issue proposed rules to reduce sulphur dioxide emissions by 50% from existing utility and industrial boilers [13].

Acid rain alters the natural cycling of nutrients on the forest floor. Acids affect life forms that decompose the leaves and needles that revitalize soils. Acids also break apart normal chemical bonds, freeing calcium, magnesium, and toxic levels of aluminum. Essential nutrients such as calcium become scarce in thin soils. Aluminum, plentiful in all soils, is liberated and may interfere with the uptake of water and other elements by roots. The symptoms of acid rain damage to trees are not limited to any one region, any one type of tree, or any one age of forest. The symptoms are pervasive.

d) Acid Rain can reduce the yield and marketability of important crops.

It has been demonstrated that acid rain significantly reduces the productivity of soybeans, one of the United States' most important crops.
— Field grown soybeans experienced decreases in yield of 11%, 17% and 23% when exposed to simulated acid rain of pH 4.1, 3.3 and 2.7. Every 1% reduction in yield represents a $50 million loss in annual revenues [14].
— Necrotic spotting following exposure to simulated acid rain has reduced the marketability of tomatoes, lettuce, radishes, apples and other crops [15]. When acid rain mixes with other pollutants, the combined effects may be greater than the sum of the individual effects.

e) Metals are leached from the ground and from corroded water supply systems by acid rain.

Health officials in Minnesota, New York, and Ontario are advising residents in rural areas to flush drinking water pipes and to restrict consumption of freshwater fish in order to avoid exposure to unsafe levels of metals. Acid rain can:
— increase the acidity of drinking water supplies so that they fall below the U.S. standard of pH 6.0 [16];
— leach metals such as lead and copper from drinking water supplies to levels that exceed the U.S. and Canadian standards [17];
— leach dangerous metals such as cadmium, aluminum, and mercury from soils into drinking water supplies; and
— increase mercury levels in lakes and fish. Fish with mercury levels that exceed the U.S. standard of 0.5 ppm have been caught in the acidified lakes of Minnesota and New York's Adirondack Park [18].

f) Reducing the sulphur dioxide and sulfates that cause acid rain would lessen significant health risks and improve visibility.

Suspended sulfates are fine particles which are inhaled deep into the lungs and are directly responsible for damage to public health. Statistical studies indicate that sulfate may be the cause of tens of thousands of early deaths. A recent U.S. federal study concluded that sulfate pollution may contribute to 51 000 early deaths per year in both Canada and the United States [19]. The study indicated that five times that number suffer from sulfate-related illnesses including:
— increased frequency of attacks in asthmatics;
— worsened symptoms in cardiopulmonary patients;
— acute and chronic respiratory diseases in children and adults; and
— decreased ventilatory function in school children.

While these studies are not universally accepted, the health risks suggested by them would be reduced by controlling the pollutants that cause acid rain.

Sulfate particles are also responsible for the majority of the haze over much of the eastern United States. The increase in haze corresponds closely with the increase in emissions in the U.S. Midwest and Southeast.

g) Acid rain damages buildings and property.

The National Academy of Sciences estimates that $2 billion in damage is done to buildings and monuments every year [20]. Acid rain also corrodes metals and automobile finishes. The accelerated erosion of the stone of the U.S. Capitol Building, the Parliament buildings in Ottawa, the great cathedrals in Europe, and the Parthenon of ancient Greece by acid rain is raising concern about the preservation of our cultural heritage.

3. The Cause of the Problem

Acid rain is caused by air pollution from electric utilities, industrial facilities, and motor vehicles. The pollutants are often carried hundreds of miles from their origin. The prime culprits are sulfur and nitrogen oxides, of which sulfur oxides are greater in amount and more environmentally damaging. The National Academy of Sciences has stated, "The control of emissions of sulfur and nitrogen oxides from fossil fuels is necessary to halt the acidification of sensitive aquatic ecosystems" [21].

a) Sulfur and nitrogen oxides are the main causes of acid rain.

More than 99% of the sulfur oxides and 90% of the nitrogen oxides emitted in the East come from power plants, industry and automobiles [22]. Millions of tons of sulfur and nitrogen oxides are emitted into the atmosphere every year [23]. According to 1980 figures:
— in the eastern U.S., over *22 million tons* of sulfur oxides were emitted, with power plants contributing 73% and industry 17% of the total loading;
— in the eastern U.S., over *14 million tons* of nitrogen oxides were emitted, with power plants contributing 34%, industry 17%, and automobiles, trucks and other mobile sources 44%;
— nationally in the U.S., *21 million tons* of nitrogen oxides were emitted, with power plants contributing 30%, industry 21%, and mobile sources 44%;
— in Canada, *5.25 million tons* of sulfur dioxide were emitted, with non-ferrous smelters contributing 45%, electric utilities 16%, and other industrial, residential and transportation sources 39%; and
— Canadian nitrogen oxide emissions totalled *2 million tons*, with transportation sources producing 61% and the remainder from industrial sources and fuel combustion.

Most coal-fired power plants do not control their emissions of sulfur oxides and nitrogen oxides. Old plants emit an average of 8 times the sulfur oxides that new, cleaner plants emit. Only a few of these dirtier, old plants will be retired in the next two decades. The majority will continue to pollute and, together with new sources, will add another 3 to 5 million tons of sulfur oxides and another 6 to 9 million tons of nitrogen oxides to emission levels.

The 1981 report of the National Academy of Sciences states: "(We) find the circumstantial evidence for (the) role (of power-plant emissions in the production of acid rain) overwhelming..." [24]

Sulfur and nitrogen oxide emissions are transformed into acid rain. Sulfur and nitrogen oxide emissions from various sources are mixed in the atmosphere with moisture and other pollutants. Out of this chemical soup, nitrates and sulfates are produced, among them nitric and sulfuric acids. The amount of acid deposited depends on how much sulfur and nitrogen oxide are emitted into the air, not on some chemical "catalyst" or intermediary. It is clear that "what goes up, must come down."

The acid material can stay in the atmosphere, riding the winds for up to 6 days before being brought down to earth. Some is deposited on the ground in dry form, causing damage when moistened; some comes down as acid rain, snow, sleet, or fog.

b) Long-range transport of sulfur oxides and sulfates is the dominant source of acid deposition over much of the East.

Most of the sulfur deposited in rural areas of the northeast and eastern Canada originates far away, often in the Ohio River Valley.
— The U.S. National Commission on Air Quality reported to Congress in 1980 that, on average, 70–90% of sulfate con-

centrations in any state in the eastern half of the U.S. originate outside the state [25].
— Ohio sulfur emissions are *30 times* greater than the sulfur in Ohio rainfall. For Maine, on the other hand, there is much more sulfur in rainfall than is emitted from sources in the state [26].
— The U.S. contributes half of the sulfates deposited over eastern Canada [27].
— Canadian sources contribute about 24% of the wet sulfur deposition in the Maine / Vermont / New Hampshire sensitive area [28].

c) The total amount of sulfur deposited is the most relevant measure of damage.

Sulfur oxides and sulfuric acid are the most important contributors to change in soils and to lake and stream acidification.
— Sulfur oxides pass largely unabsorbed into lakes and streams, unlike nitrogen oxides which are more readily absorbed by soils and plants.
— Sulfur oxides in any form threaten acid sensitive ecosystems.
— Sulfur oxides are responsible for the low pH of the rain over eastern North America and are the major cause of damage.

The total loading of sulfur oxides and acid rain has caused extensive damage in places such as the Adirondacks of New York, the Poconos of Pennsylvania, the Sudbury Basin in Ontario, and areas of Quebec and Nova Scotia. These places warn of more widespread damage in areas that are equally sensitive but have not received as much pollution year after year. Like a time bomb ticking away, vast areas of North America are losing their capacity to absorb acid rain. The longer we wait, the larger the damaged areas will become.

4. The Solution

Amendments to Canadian and American air pollution legislation are needed to control acid rain. Current law focuses primarily on controlling *local* air pollution. It is not adequate to prevent the problems caused by pollutants transported across state, provincial and national borders.

The only effective way to control acid rain damage is to reduce the pollution that causes acid rain. The National Commission on Air Quality, the National Governors' Association, and numerous other government bodies and air pollution professionals have recommended that the U.S. Congress enact region-wide programs for reducing sulfur oxide pollution.

In Canada, regulations reducing current Canadian sulfur dioxide emissions by 25% with specific reference to acid rain control are now on the books, and the federal Environment minister has promised a 50% cutback in eastern Canadian sulfur dioxide emissions by 1990 contingent on parallel American action.

The National Academy of Sciences recommends that acid deposition be cut by 50% to protect the resources at risk. To achieve this goal, sulfur oxide emissions must be cut by at least half and nitrogen oxide emissions must not be allowed to increase.

Position of the Canadian Tourism Industry and The Canadian Coalition on Acid Rain

We support adoption of a regulatory program to reduce sulfur dioxide emissions and thereby reduce acid rain. The program should protect water, air, agricultural and forest resources and the public health of Canada and the United States. *In the U.S.*, Congress should enact an acid rain control programme that will:
— reduce sulfur oxide emissions in 31 eastern states by 50% from 1980 levels within the next ten years, including meaningful reductions during the interim years;
— give the Governors the initial opportunity to allocate the emissions reductions among the states and, within the states, among utility and industrial sources;
— provide for a federal allocation formula, if the Governors fail to agree on an interstate allocation. Emission reduction obligations should be allocated among states according to the relative contributions of each state's utilities to the region's sulfur dioxide emissions;
— provide for regional trading ("bubbling") of emission control obligations so that companies can choose the most inexpensive method of emissions reduction;
— require that any increase in sulfur dioxide emissions be simultaneously offset; and
— require that increases in nitrogen oxide emissions from 1980 levels be simultaneously offset.

This acid rain control program should also:
— provide incentives for sources to use technologies which reduce nitrogen oxide as well as sulfur dioxide;
— eliminate the loop-hole in section 123 created by EPA regulations that allow the largest sources of sulfur dioxide to use tall smokestacks to evade pollution control;
— strengthen enforcement procedures for existing provisions of the Act dealing with interstate and long-range transport;
— retain the Act's mobile source nitrogen oxide emissions limit;
— require EPA to increase research and fund commercial demonstrations of new, less expensive technologies for reducing sulfur and nitrogen oxides; and
— increase research to further document and quantify the resource damage from acid rain.

This program would greatly improve the quality of the environment at reasonable cost. The benefits of a control program would be large:

— less damage to lakes and streams;
— lower risks to forests;
— improved visibility;
— reduced corrosion of buildings, monuments, and drinking water systems; and
— protection against risks to human health.

The program sets a target for clean-up and allows the states and regulated industry maximum flexibility and economic efficiency in achieving the goal. Analyses conducted by the National Clean Air Coalition, the National Wildlife Federation and EPA of similar programs introduced in Congress last year show that the annual costs of effective controls would be far less than the estimated damage caused by acid rain every year in the eastern United States. The NCAC / NWF analysis demonstrated that a 40% reduction in eastern sulfur oxide

emissions would cost $2.4 billion per year and would result in an average electricity rate increase of 2%.

An EPA analysis, which did not study the most cost-effective strategies for sulfur oxide reductions, demonstrated that a 35% reduction in sulfur dioxide emissions would cost $3 billion per year and would result in an average rate increase of only 2.7% [29].

Both analyses show electricity rates would *still* be significantly lower in the midwest than in the northeastern and mid-Atlantic states even with a control program.

In Canada, further action must be taken to reduce sulfur and nitrogen emissions from mobile and stationary sources:
— the Canadian federal nitrogen oxide emission standard for light duty vehicles must be tightened from its present 3.1 gram/mile level to 1 gram/mile;
— the current maximum daily allowable emission limit at the Inco Ltd. smelter at Sudbury of 1,950 tons per day must be cut by at least 50% by the end of the decade;
— emissions of sulfur and nitrogen oxides from Ontario Hydro's fossil fuel-fired power plants must be cut by at least 50% by 1990;
— emissions from the Noranda Mines smelter at Rouyn, Quebec, must be cut by 50% by 1990; and
— emissions from the Inco Ltd. smelter at Thompson, Manitoba and the Hudson's Bay Mining and Smelting smelter at Flin Flon, Manitoba must be reduced by 50% by 1990; and
— similar actions must be taken with respect to coal-fired utilities in the Maritime provinces.

This program follows the traditional source-by-source regulatory concept employed by Canadian governments in reducing air pollution emissions, and will guarantee that both the domestic impacts of acid rain are reduced and that the contribution that central Canadian sources make to the Maine/Vermont/New Hampshire/northern New York sensitive areas are significantly reduced.

5. Opposition to Meaningful Acid Rain Controls

The U.S. Administration and industry groups on both sides of the border either oppose outright the programmes above or believe that emission controls substantially less than those noted above will adequately control the problem. In some cases, they still claim that not enough is known to justify significant reductions of the pollution that causes acid rain.

But the National Academy of Sciences, the U.S.'s foremost independent scientific body, more than a year ago stated that:

> "It is the Committee's opinion, based on the evidence we have examined, that the picture is disturbing enough to merit prompt tightening of restrictions on atmospheric emissions from fossil fuel and other large sources such as metal smelters and cement manufacture. Strong measures are necessary if we are to prevent further degradation of natural ecosystems which together support life on this planet" [30].

Additional years of delay in adopting a program are unacceptable for two important reasons: first, the damage caused by acid rain is cumulative and, in some cases, irreversible; and, second, lead time is necessary to implement a control program.

Damage to lakes, streams, and soils shows up only after a number of years of accumulated deposits of acids. How many years depends largely on the "antacid" capability, or buffering capacity of the terrain receiving acid rain. The reports of the U.S. National Academy of Sciences and the U.S. Office of Technology Assessment, and Canadian federal and provincial governments indicate that the ability of lakes and streams to buffer acids is being depleted in many areas of the United States and Canada.

To slow the loss of lakes and streams and to reduce other damage caused by acid rain requires at least several years lead time to develop and implement control programs. Planning and commitment will have to start well before actual reductions in acid rain can be expected.

The costs of acid rain control must be related to the damages which will almost certainly occur if acid rain-causing emissions continued unchecked. While significant damage has already occurred, we believe the current situation is nothing compared to what will occur by the end of the century if substantial control measures are not taken now. To illustrate, the Canadian tourism industry generates more than $16.5 billion in annual revenue, or 5% of the Canadian gross national product. The industry employs 1.3 million Canadians in 100,000 tourism enterprises. In Ontario alone, the fishing, hunting lodge and camp industry generates $250 million and employs about 50,000 people. There are 1.2 million recreational boats in Ontario, and the recreational boating industry there generates $800 million in revenue, including $200 million in taxes. In 1980, Ontario residents spent $338 million on travel related to sport fishing, while wages, salaries, and business profits in the sport fishing sector generated $557 million during the same year.

We strongly believe that any damage in excess of that having already occurred will have a significant impact on the economic health of the tourism industry, and on the availability of recreational opportunities for Canadians.

Acid rain is perhaps the most serious unaddressed environmental problem on the North American continent today, already causing damage conservatively estimated in the eastern United States alone at $5 billion per year. The Canadian tourism industry and The Canadian Coalition on Acid Rain believe that the above program must be enacted now, since it will be a number of years before the benefits begin to be felt. We do not pretend that this program will be without cost, but we are convinced that the threat to North America's tourism and recreation industry, natural resources, and the health of the inhabitants of Canada and the United States is so much greater than the cost of any control program not being considered, that action as outlined above is warranted *now*.

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A Statement on Acid Rain

from

A Consultation of Canadian and U.S. Religious Bodies held in Toronto, Canada

January 11–13, 1984

Introduction

Acid rain has been described as one of the most serious threats to the environment. As such, it represents a major destructive force to God's creation. If religious bodies are to take seriously their committment to responsible stewardship of the earth, they must be prepared to address the problem.

With this recognition in mind, participants from 25 religious bodies in Canada and the United States gathered for 3 days to: review scientific information about acid rain; discuss the issue with representatives from industry, labour, government and environmental groups; reflect theologically on relevant questions of stewardship and justice; and plan joint strategies to commend to their religious bodies to involve them in efforts towards solutions. This statement reflects the consensus of the participants and was adopted by them on the final day of the Consultation.

Our Understanding of the Acid Rain Problem

While acid rain is a complex, international issue, there is significant consensus in the North American and European scientific communities concerning the sources, processes and effects of acid rain. Some general statements about the problem can be made as follows:

1) Research points to an association of the short and long range transport of sulphur dioxide and nitrogen oxide emissions as the major contributors to the acidification of the environment, with consequent damage to water systems, plant life, fish, forests, buildings and potentially human health.

2) The major sources of sulphur dioxide emissions are non-ferrous smelters in Canada and fossil-fuel-fired power plants in the U.S., with many other contributing sources in both countries such as non-utility fuel use and industrial processes.

3) The major sources of nitrogen oxide emissions in both Canada and the U.S. are transportation vehicles, industrial processes, and fossil-fuel-fired power plants.

4) Acid rain is an undesirable side effect of the current North American industrial economy and associated lifestyle. It is one of the costs we North Americans pay for our enjoyment of abundant and inexpensive energy and readily available metals. Although it is probably possible to control acid rain and still maintain our highly consumptive lifestyle, the cost will have to be paid in other areas of our lives, our economy or the environment to the extent that we decline to make changes in the way we live toward a more ecologically sustainable way of life.

5) Degradation of our waters, soils, plant life and buildings is occurring over large geographic areas and will increase unless substantial reductions in sulphur dioxide and the oxides of nitrogen begin now. Such emission reductions are the only way to prevent damages associated with acidification of the environment.

6) Technologies already do exist to effect considerable emission reductions.

7) Any assessment of the costs of reducing emissions must be compared with the economic, ecological, health and other social costs of not stopping acid rain. These costs include many non-market values.

8) Legislative, regulatory and fiscal arrangements will have to be developed which ensure that the costs are distributed equitably (with specific protection for low income households), that the polluting sources assume an appropriate degree of responsibility, and that labour benefits from strategies to control pollution.

9) Opinion polls indicate that the public considers acid rain to be a serious problem and is prepared to share in the costs of abatement.

10) In both Canada and the U.S., specific, enforceable steps to reduce sulphur dioxide and nitrogen oxide emissions are urgently required. Abatement measures should be instituted in addition to those already in place.

11) Negotiations on a transboundary air pollution agreement between Canada and the U.S. should resume as quickly as possible. The resolution of the acid rain problem will set a precedent for the resolution of other international air pollution problems such as ozone, carbon dioxide, fluorocarbons, and local air pollution problems.

Our Theological Understanding

As Christians we affirm that:

1) God as Creator of heaven and earth and all earth's creatures looks lovingly upon all the works of creation and pronounces them very good. God continues to care for creation and to fill all the creatures with good things.

2) God as Deliverer acts to protect, restore and redeem the earth and its creatures. These have become co-victims with all humanity, victims of the sinful pride and greed that seek unwarranted mastery over the natural and social orders, and the sinful sloth and carelessness that refuse responsibility for understanding and serving God's world.

3) God as Jesus Christ has acted to reunite all things and to call the human creature back to the role of the steward, the responsible servant, who as God's representative cares for creation and acts in society for the sustenance and fulfillment of the one human family.

4) The Creator–Deliverer acts in the ecological–social crisis of our time to demonstrate that same divine love which was manifested in the cross of Christ; and we as a convenant people are called to increase our stewardship, in relation both to nature and to political economy, to a level commensurate with the peril and the promise with which God confronts us in this crisis.

5) Human stewardship is not a dominion of mastery. It is a dominion of unequivocal love for this world. It is to be exercised with respect for the integrity of natural systems and for the limits that nature places on economic growth and material consumption. As stewards:
— we seek a political economy directed to the protection of the poor and to the sufficient and sustainable sustenance of all people.
— we accept the responsibility of using political processes to check the abuses of power that would otherwise continue to victimize the earth and the poor; and
— we insist that the costs of restoring the polluted environment and structuring sustainable practices and institutions be distributed equitably throughout our society.

Public Policy Guidelines

In response to the critical problem of Acid Rain and in the light of Christian theology, we support public policies that are consistent with the following guidelines:

1) Vigorous national and international action including bilateral cooperation between the governments of the United States and Canada to control acid rain.

2) Cleanup of sufficient magnitude to reduce emissions of sulphur dioxide and oxides of nitrogen to a level necessary to protect the health of our most sensitive environments and individuals.[1]

3) Industrial and pollution abatement/control strategies that:
   a) are environmentally sound;
   b) preserve existing jobs and create new ones;
   c) protect the poor; and
   d) encourage energy conservation and renewable energy systems.

4) Adequate funding of cleanup that will:
   a) achieve by 1990 the necessary reduction of emissions that cause acid rain;
   b) distribute costs fairly among corporations, governments and consumers taking specific steps to protect the poor; and
   c) support research into environmentally sound technologies.

5) Increased citizen participation in the legislative, regulatory, judicial, and corporate accountability processes pertaining to sources and reduction of acid rain. This requires more citizen access to, and review of information regarding government and corporate cleanup plans.

6) Rigourous enforcement of clean air laws and regulations consistent with the above objectives.

Conclusion

This statement describes the approach that the Consultation agreed needed to be taken to stop acid rain in the U.S. and Canada. National Caucuses of the U.S. and Canadian participants developed specific strategies to recommend to their religious bodies for how to proceed toward that goal.

The intention of Consultation participants is that their churches be involved in the effort against acid rain. This statement is a first ecumenical, bilateral step. But it is only the beginning. Working against such a serious threat to God's creation as acid rain will require much commitment, perserverance, energy and faith.

Report From the Caucus of Participants From Canadian Religious Bodies

Political/Advocacy Strategies

We recommend that Canadian religious bodies:

a) Request the Canadian federal and provincial governments to abandon their policy of not requiring further emission reductions in Canada until the U.S. is prepared to act; recognizing that 50% of Canada's acid rain problem originates within its own borders, Canada should proceed unilateraly to reduce its own emissions and use such action to reinforce its pressure on the U.S.

b) Request the Department of Energy, Mines and Resources of the federal government to release as soon as possible the Study on the Smelter Strategy Work Program to speed up modernization of smelters that would reduce emissions.

c) Deplore the fact that there is no reduction plan in effect at Noranda's Horne Smelter facility which is the second largest point source of SO_2 emissions in North America, and request that Canadian and Quebec governments order Noranda to make significant reductions.

d) Request the Canadian and Ontario governments to require a further reduction of emissions at INCO's Sudbury facility.

e) Request the Canadian government to move quickly to tighten the standards for nitrogen oxide emissions to 1 gm/mile for motor vehicles which is the existing U.S. standard.

f) Request the Ontario Government to require further reduction of emissions by Ontario Hydro facilities and to require Ontario Hydro to redirect its policy from promotion of electrical use to conservation which would reduce energy demand including that which is nuclear produced.

g) In order to facilitate public discussion about appropriate reduction levels, request the Canadian Government to release the apportionment strategies agreed upon by the Environment Ministers of the federal government and the provinces from Manitoba, east.

h) Ask the federal and provincial governments to ensure that there is no reduction in any research related to acid rain, and to increase research in needed areas including the effects of acid rain on forests and agriculture.

i) Remind the federal and provincial governments that reducing emissions in Canada will also reduce the emissions that flow to the U.S. which would be consistent with principles of stewardship, neighbourliness and international law.

j) Endorse the "United States/Canada Citizen's Agreement on Acid Rain."

Further, we recommend that Canadian religious bodies:

a) Use appropriate strategies to generate understanding and support of these recommendations in their churches and to communicate these concerns to political leaders, opposition critics, local MPs and MPPs/MLAs, as well as to the industries responsible for the emissions.

b) Commit themselves to developing further educational and action strategies collaboratively and with U.S. churches

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[1] Current evidence suggests that SO_2 emissions must be reduced in the U.S. and Canada by 50% from 1980 levels, toward reducing wet sulphate deposition to less than 18 lb/acre/year (20 kilograms/hectare/year) to protect moderately sensitive areas and 8 lb/acre/year (9 kilograms/hectare/year) to protect extremely sensitive areas.

to broaden and deepen the level of ecumenical activity on acid rain and other environmental and energy issues.

c) Become members of The Canadian Coalition on Acid Rain.

Report From the Caucus of Participants from U.S. Religious Bodies

Participants from the USA included representatives of seven denominations and the National Council of Churches, and involved a mutually energizing mix of Stewardship and Church/Society persons. With the exception of environmental work in the corporate responsibility area, there is no history of substantial national U.S. ecumenical efforts on environmental issues. This Consultation served as a catalyst for the commitment of time and resources to deal together with the immediate need for education and organizing in our churches around pending legislation in the U.S. Congress which should be acted upon in the next 6 months.

Specifically, the U.S. participants agreed to urge full denominational support for the initiative taken by some of their Washington staff in supporting coalitional efforts for education about legislation requiring a twelve million ton reduction in annual SO_2 emissions in the shortest possible time, along with a substantial decrease in nitrogen oxide emissions. Participants agreed to work with the National Clean Air Coalition on this.

Educational materials to be widely distributed through existing denominational and ecumenical networks will include the statement from this Consultation and an Acid Rain "Brief" being prepared for National IMPACT. Congregations will also be urged to study the "Citizens' Agreement" from the Citizens' Conference to Stop Acid Rain (just held in New Hampshire), with which we are in agreement.

Educational/organizing projects will be undertaken in a few geographical areas which are key to effective action on this problem. Ongoing corporate responsibility work will be encouraged and integrated into these programs.

Representatives of the American Baptist Churches, the Presbyterian Church (USA), and the United Methodist Church each committed funds for this work; and other four denominations will be urged to provide comparable support. Chris Cowap the NCCC's Director for Economic and Social Justice will serve as staff coordinator for the group.

UNITED STATES–CANADA

CITIZENS' AGREEMENT

Air pollution and associated acid rain are causing extensive damage to the environment and the health of citizens in the United States and Canada. Without immediate action to stop acid rain, irreversible damage will continue with severe consequences to human health and the economies of both countries.

Presently, both countries emit SO_2 pollution some of which travels across the border and contributes to the other nation's problems. Consequently, to stop acid rain, the U.S. and Canada must take co-operative action.

The citizens of the United States and Canada therefore urgently call upon our respective governments to establish a joint United States/Canada Acid Rain Control Program which will:

1) Commit each country to reduce SO_2 emissions by 50% toward reducing wet sulphate deposition to less than 18 lb/acre/yr (20 kg/hectare/yr) in moderately sensitive areas and 8 lb/acre/yr (9 kg/hectare/yr) in extremely sensitive areas.

2) Implement acid rain control strategies to achieve this objective by 1990 with significant interim reductions.

3) Establish a mechanism to insure compliance with the stated goals and objectives of the Acid Rain Control Program.

Agreement adopted by the Citizens' Conference To Stop Acid Rain, Manchester, New Hampshire, January 6–8, 1984.

List of Participants/Liste des Participants

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